

Electrical Engineering

November
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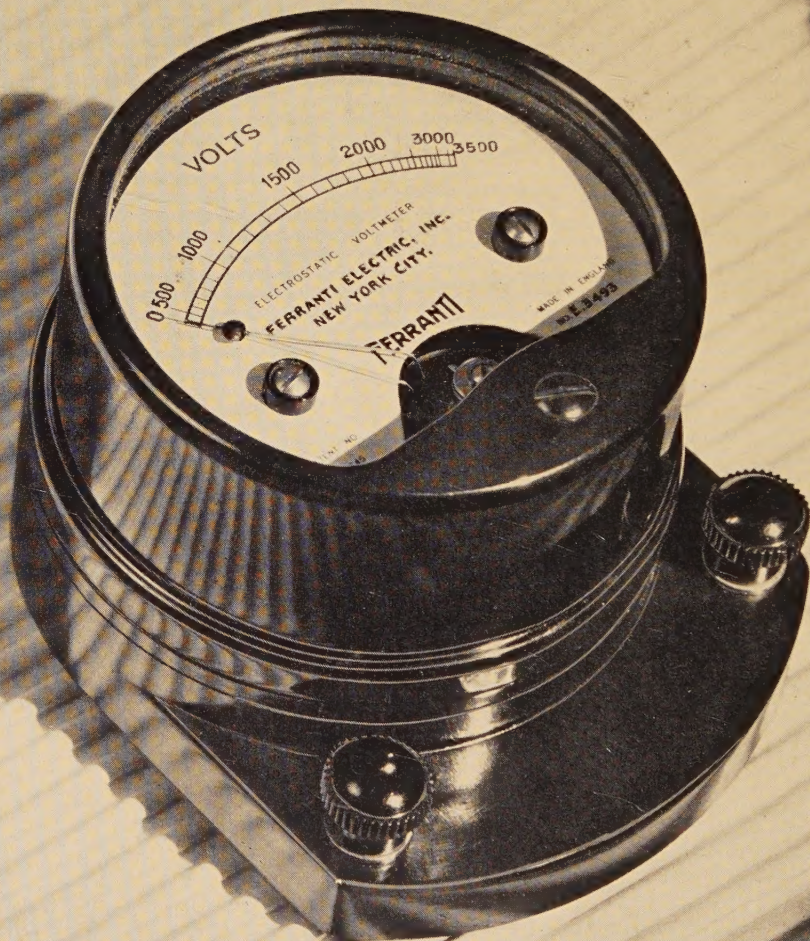


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Electrical Engineering

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for November 1938—

Training Engineering Graduates in Industry	... L. W. W. Morrow	...441
The Paradox of Social Progress	... Robert E. Doherty	...444
Influence of Utensils on Heat Transfer From Range Units	... W. George Short	...449
Graphics in the Solution of Complex Quantities	... E. C. Goodale	...453
Sterilization by Ultraviolet Radiation	... Samuel G. Hibben and P. W. Blackburn	...455
Abstracts: Graphical Field-Plotting Methods in Engineering, 448—Absolute Power Factor of Air Capacitors, 452 —Stability Characteristics of Turbine Generators, 459—Symbolic Analysis of Switching Circuits, 459		
News of Institute and Related Activities (See next page)		...460

Transactions Section—Papers and Correlated Discussions (Follows EE page 474)

Noise Co-ordination of Rural Power and Telephone Systems	... H. W. Wahlquist and T. A. Taylor	...613
The Wound-Core Distribution Transformer	... E. D. Treanor	...622
Radio Influence Characteristics of Electrical Apparatus	... P. L. Bellaschi and C. V. Aggers	...626
A Position Regulator for Paper Slitters	... F. H. Gulliksen	...634
A Static Constant-Current Circuit	... C. M. Summers	...636
Analysis and Design of Harmonic Generators	... Frederick Emmons Terman	...640
The Electric Strain Gauge	... M. A. Rusher and A. V. Mershon	...645
"De-ion" Air Circuit Breakers	... R. C. Dickinson	...649
Enclosed Low-Voltage "De-ion" Air Circuit Breaker	... Jerome Sandin	...657
Line-Type Lightning Arrester Performance Data	... AIEE Subcommittee Report	...661

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The Cover

Miami, Fla., scene of Southern District meeting November 28-30, across Biscayne Bay

Photo by G. W. Romer



High Lights

Circuit Breakers. Compact design of an air circuit breaker may be obtained by forcing the arc caused by the operation of the breaker into a series of arc spaces, where the rapid development of a thin layer of dielectric material at the cathode interrupts each individual arc. Such breakers may be used on voltages up to 25 kv (*Transactions* pages 649-57). By modifications in design, a new air circuit breaker, providing protection against fault currents up to 20,000 amperes at 250 volts on direct current or 600 volts on alternating current, has been produced (*Transactions* pages 657-61).

Constant-Current Circuit. A constant-current circuit without moving parts may be constructed by connecting an iron-cored reactor with predetermined characteristics in parallel with a capacitor of such size that the resultant input current is independent of line voltage. The parallel circuit is connected in series with the element through which the current is to be regulated (*Transactions* pages 636-9).

Position Regulator. Among other industrial applications for photoelectric tubes are many devices used for simplifying or improving the accuracy of operation in the manufacture of paper. A recent comer to this family of devices is a position regulator, used for the accurate trimming of paper webs, so that a roll of paper with even sides may be wound from an unevenly wound roll (*Transactions* pages 634-6).

Noise Co-ordination. Investigation has shown that satisfactory co-ordination of power and telephone facilities in rural areas for the reduction of noise in the telephone circuits can be secured by control of the influence and susceptiveness of the circuits. One of the measures that may be applied to the power system is the use of shunt capacitors to improve the wave shape (*Transactions* pages 613-21).

Electric Strain Gauge. An offspring of a vibration recorder originally described in 1926, the electric strain gauge measures mechanical strain electrically, and has been valuable in the study of stresses in railroad tracks and bridge members. As described in this issue, it is equally successful in measuring the strain in machine parts subjected to stress (*Transactions* pages 645-8).

Radio Noise. Electrical apparatus may cause noise in radio receivers of such magnitude as to impair reception in some circumstances. A method of measuring the radio-influence characteristics of apparatus was recommended by a joint committee,

and laboratory experience now shows that the method is practicable and gives results that are reproducible by quantitative measurements (*Transactions* pages 626-33).

Wound-Core Transformers. For years the most satisfactory type of transformer core has been made from sheets or punchings of sheet steel assembled about the windings in such a way as to require little power for supplying eddy-current losses and magnetizing current. Now a low-loss transformer may be assembled by winding the core around the finished coils by machine (*Transactions* pages 622-6).

Harmonic Generators. Experience usually is the only guide in designing and adjusting harmonic generators, such as those used in radio transmitters. In this issue a new method of analyzing the harmonic generator is presented. It requires very little tedious computation, and is sufficiently accurate for practical design (*Transactions* pages 640-5).

Lightning-Arrester Performance. Continuing a previous report on the performance characteristics of lightning arresters of the line type, the lightning arrester subcommittee of the AIEE committee on protective devices presents in this issue a report of the characteristics of arresters rated at from 20 to 73 kv (*Transactions* pages 661-2).

Range Utensils. Electric range units are of various types, heat being transferred from the unit to the contents of a utensil by conduction and radiation in proportions according to the type of unit. Efficiency of heat transfer is affected greatly by the kind of utensil, some combinations of units and utensils differing in over-all efficiency by as much as 24 per cent (*pages* 449-52).

Paradox. On the basis that the very improvement of production that might save us from economic and social collapse might increase rapidly the complexity of social organization and hence lead to the same collapse, an engineering educator proposes "planned education" in order that new professional generations may learn how to cope with these increasing difficulties (*pages* 444-8).

Training Graduates. Engineering graduates have shown themselves to be the best material for filling technical and administrative positions of responsibility in industry; proper training by industry is necessary to qualify them as executives capable of solving the perplexing problems of modern business (*pages* 441-4).

Southern District Meeting. A well-rounded program has been planned for the AIEE Southern District meeting, to be held November 28-30, 1938, in Miami, Fla. Besides carefully planned technical sessions, many interesting sight-seeing trips and other diversions are to be provided (*pages* 460-61).

Graphics. Solving equations containing complex quantities usually is a laborious task, especially by means of the conventional analytic methods. A graphic method for simplifying the usual manipulations of complex quantities is presented in this issue (*pages* 453-4).

Ultraviolet Sterilization. Radiation in the ultraviolet region at wave lengths of some 2,600 Angstroms has been known to kill bacteria and microorganisms, but only recently has a device or "lamp" been developed to produce this radiation conveniently (*pages* 455-9).

Coming Soon. Among special articles and technical papers now undergoing preparation for early publication are: an article on engineering and the law by C. W. Appleton; an article on high-voltage dielectrics from the chemical standpoint by F. M. Clark (A'24); an article on glass insulation by R. E. Ferris and G. L. Moses; an article on lightning studies by K. B. McEachron (F'37); a paper on positive-grid characteristics of triodes by R. W. Porter (A'38); a paper on remote control of network protectors by W. R. Brownlee (M'38) and W. E. Dent, Jr. (A'38); a paper describing a new multibreak interrupter for circuit breakers by R. M. Spurck (F'37) and H. E. Strang (A'28) and a paper describing tests on such a breaker by Philip Sporn (F'30) and H. P. St. Clair (M'29); a paper on system analysis for application of Petersen coils by W. C. Champe (M'35) and F. Von Voigtlander (A'29); and a paper on the fundamental principles of fluorescence by G. R. Fonda.

News 460

Southern District Meeting in Miami	460
Nomination of AIEE Officers for 1939 Election	462
Additional Committee Personnel Announced	462
Plans Already Initiated for 1939 Summer Convention	463
Transactions "Supplement" to Be Issued in December	463
17-Year AIEE Index May Be Issued Soon	463
American Engineering Council	464
Future Meetings	
AIEE	462
Other Societies	463
Letters to the Editor	
Critical Conditions in Ferroresonance	466
Tensors—In Words of One Syllable	466
D-C Transformers and Transmission	467
Some Electronic Switching Circuits	467
Personal Items	468
Membership	473
Engineering Literature	474
Industrial Notes (See advertising section)	
New Products (See advertising section)	
Employment Notes (See advertising section)	
Officers and Committees (For complete listing see pages 397-401, September 1938 issue)	

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Training Engineering Graduates in Industry

By L. W. W. MORROW
FELLOW AIEE

INDUSTRY develops its younger personnel to take positions of technical and administrative responsibility. Industry needs a constant influx of men to carry on its expansion programs, to replace inefficient men and those who retire, and to keep itself competitive by the introduction of employees with new ideas and fresh initiative.

It may be taken for granted that industry seeks men with certain general characteristics. They should be of good mental and social habits with quick and intelligent responses. They should be responsible and decisive, yet have the ability and tact to get along with other employees. They should have the spirit and unselfishness to build the organization as well as to try to establish their own position.

When industry looks over its records to find the type of man to train, the answer is unmistakably the young college graduate in engineering. These men have proved versatile enough to fill all technical and administrative positions. They may not be perfect, but experience indicates that they are the best available.

A sample of their accomplishments is given by the recent study made by President Karl T. Compton of Massachusetts Institute of Technology. Data on 54,000 officers of some 500 typical industries showed that the college man is 7 times more likely to be an official than the noncollege man, and that the engineering graduate is 30 times more likely to be an officer than the graduate of a nonengineering college.

This advantage of the engineering graduate over the nonengineering graduate applies to all positions. He has 12 times the chance to become president, 5 times the chance to be a treasurer, 30 times the chance to hold positions in production, 174 times the chance in engineering, and 24 times the chance in sales.

These data should be a source of stimulation and gratification to both engineering educators and the engineering profession. Moreover, they prove to industry that engineering graduates should be hired and trained.

Industrial executives accept the fact that any type of raw material in man power will develop on an individualistic basis independently of the individual's training and education, because there is little uniformity in a group of human beings. Each recruit is innately endowed with his distinctive traits and abilities. The greater is the credit, therefore, to the educators and to the formal and informal selective process applied to those who take engineering courses, to find that the engineering graduates stand out as the most competent men available for hire.

Industry must train men to fill technical and administrative positions in a business world that becomes increasingly complex with economic, social, and legal aspects. Engineering graduates have shown definite advantages over nonengineering graduates for all types of positions; industry's objective is to get the best possible men and to train them with diligence.

The time has passed wherein industry hires young engineering graduates to fill its demands for technical engineering positions only. In large measure this fact is not recognized by engineering educators or by the young engineering graduates. Experience with young engineers causes industry to hire

them to fit into all the functional positions of a business and the training process is depended upon to cull out from the group the relatively few technical men required. For one position in engineering there are a dozen in other divisions of activity and these positions seldom call upon their incumbents to use any depth of technical knowledge. Yet the engineering graduate can and does meet the specifications for these positions to best advantage.

Perhaps this comes about because of the "method of attack" alleged to be peculiar to engineering training, but it is more logical to assume that the young engineer has more familiarity with engineering processes, industrial equipment, and the underlying sciences than other college men, and thus has less fear and less unknown territory to explore in order to become useful in industries which now combine large amounts of power and complicated assemblies of machines. Engineering knowledge, however superficial, gives the young engineer confidence and a feeling that he can act and think intelligently in the industrial environment.

Essential procedure by industry in dealing with a group of young engineers can be stated briefly:

1. To find individual aptitudes, habits, and personal traits.
2. To place individuals where their talents and personal characteristics can be used to best advantage.
3. To train each man constantly in order to bring out and develop his good qualities and to eliminate or reduce those habits and characteristics that handicap him.

Whether organized as a formal training course or not, no industry invests in young engineering graduates without trying to carry out such plans for their training and selection.

Two Stages of Development

An industrial manager takes the position that each engineering graduate starts with a small capital of knowledge, experience, and personality and semifixed attitudes and

An address presented at the 18th industrial conference, Pennsylvania State College, State College, April 12, 1938.

L. W. W. MORROW is general manager of the fiber products division of the Corning Glass Works, Corning, N. Y. A biographical sketch of Mr. Morrow appeared in the October 1938 issue, page 434.

habits. For some years he is placed in an environment that permits him to add to these assets without expectation of concurrent profit to himself or to his employer. Until he reaches some measure of equilibrium between his resources and the needs of industry, he is forced to use pressure to apply his talents to the utmost in order to advance his personal position. This is almost a planned program and attitude adopted by the employer and the employee.

As the engineer grows older and learns more, his functions increase and his perspective should change from that of self-interest to that of more unselfish interest in the organization. He must change from the attitude of a follower to that of a leader. Instead of performing himself he must get others to perform. He must select men, train them, and stimulate them to think in terms of the organization. He must learn to co-ordinate the work of subordinates, to check performance, and to appraise and reward good work. To the industrial executive this second stage proves whether the man is worth-while. In this second stage the young engineer is expected to give attention to many things outside the normal routine of his personal responsibility in the business enterprise. He should concern himself with the relations of his company to society, to government, to other business, and to employees as a group. He should learn how best to measure the future and become sufficiently objective to speculate as to trends and new developments. In a degree he must grow to look at his work and his business with the critical eye of an observer.

Business executives try to help the young engineer in the initial stage and to expedite his arrival at the second stage. The first period is susceptible to a tangible course of training and measured accomplishment. But a formal technical or business training course will not suffice to bring about all that is desired in the second period. The development of a man to be broadly useful is as much, if not more, a matter of his habit and attitude than it is of imposed training schedules.

Many young engineering graduates become successful as individual workers on technical aspects of business, but fail to adjust and develop to meet the broader specifications required in leaders of men. They frequently are unwilling to teach subordinates or to trust them with any responsibility. Others rest content in specialty engineering jobs and sit back with the attitude that they have arrived, and so it is not necessary to keep up the pressure. Still others are so busy with their specialty and with details that they lack the perspective to see that success as an engineer can be made the foundation to lead to success in higher executive positions. Still others are not fitted by nature to be other than individual technical specialists.

Industry executives watch these young men grow and know that a certain number will arrive at essential cog-wheel positions in the business. But first of all they seek the man who has the determination to overcome routine and the imagination and daring that comes from seeing distant goals. They like to see a young man rise through the normal series of plateaus to a peak of usefulness, and are ready to pay the rewards that go with this accomplishment.

Training for All Positions

When they start to work most young engineers are ambitious and full of enthusiasm. They want to go places in a hurry. Perhaps their ambition is quite selfish and personal and takes the form of desiring a wage increase every three months, and a position as vice-president in four or five years. They start out to work for themselves and not for the company. The first step in training these men is to change this attitude of selfish and rapid personal advancement. Perhaps the static and slow changing tempo of old established industries is not sufficiently understood these days. Industry expands slowly in income, plant, and personnel. It also is more complicated and functionalized so that it takes longer for a man to "learn a business" in a measure that makes him fitted for higher positions.

Much of industrial activity is repetitive with few changes and slow progress. Men are needed for this kind of job and a large number of young engineers are fitted into semi-static positions, but even so, these men must meet specifications that are broader than those involved in technical competency. They must measure up to the requirements of a good foreman as a minimum. But industry also needs the limited few that are creative; men with powerful and unsatisfied dreams and ambitions which will motivate them to put their talents to work to keep the business aggressive and progressive. Men are wanted with the imagination to conceive and the talent to accomplish despite obstacles.

Thus training is used to develop all kinds of men for all kinds of positions. This training is largely a matter of forming good habits by use of repetition and counsel. Little can be added to the natural ability of men, but they can be helped and developed. Industry tries to do its part by keeping them interested, in good physical and mental condition, and in a fertile environment. Executives give these men tests to try their initiative, mixing ability, judgment, and responsibility. They apply discipline as well as stimulation. They give opportunity for these men to form good habits in business as well as to use all their mental and personal assets. Business leaders try to have all employees seek more than a customary wage for customary work. An employee is developed to have the greatest value to the organization by training him to have his desires and ambitions focused, an interest in his work, and an aggressive and confident attitude toward it.

The addition of a man to a business organization involves more than an expense. It exposes the organization to possibilities for good and for evil. Each recruit has certain native qualities, such as intelligence, mental alertness, appearance, and personality. He has acquired other qualities, such as his attitude, his manners, his education, and his knowledge of the world. These acquired qualities are of equal importance to his native or hereditary qualities. Industry ranks of the greatest importance the character of an employee, that is, his individual philosophy of life and his personal standards of conduct.

The acquired qualities and character of a man can be

changed by education and experience, but this may be difficult. As an example, a young man who has been an ardent socialist in college with a hostile attitude toward the capitalistic system will not change this attitude because his employers tell him to do so. He is far more apt to seek disciples among his fellow employees and to become a disturbing element, because he is more interested in his cause than in his work. No one will gainsay his privilege of holding his opinions and trying to put them into operation but on the basis of equal fairness, no one can blame an industrial executive for declining to employ such a man.

In this connection many leaders in the business world are not sold on the idea that engineering graduates would be better material to employ if they had a so-called "broader culture" through more courses in economics and sociology. Too much evidence exists that the womb of many "isms" and challenges to the fundamentals of our American system is these departments of our universities to make them accept this as a method to liberalize and broaden engineers.

Despite the pressure on engineers to be liberal and cultured, it is not recognized that these qualities are largely attitudes rather than responses to knowledge. There seems to be no prescription for use in colleges to impart culture. Nor can one expect a young man in his formative years to have the experience and the perspective to deal with the broader aspects of humanity and civilization on an intelligent basis. He is more interested in getting a job, in mixing with his fellow workers, in his ability to live on \$30 a week and in making good, than he is in theories of government of business conduct. It is doubtful if a few courses in any college will give him the wisdom and experience that comes with the years. They are more apt to infect him with half-baked ideas that handicap him when he faces his immediate job in life. This is to go to work and produce results.

No business manager will disagree with the statement that his hardest job lies in dealing with personnel. He knows that success or failure rests largely on a foundation of competent and happy employees. And happy is just as important as competent and often more difficult to achieve.

Problem of Reward

It is not particularly difficult to select and to train personnel. Yet in any going concern there is soon reached a stage wherein the personnel is trained and competent and the turnover low. The most difficult thing for the manager is to expand the business at a rate that will permit personnel to advance at a rate commensurate with their growth in competency and business capacity. We have reached a stage in this country wherein old established enterprises cannot grow larger and larger each year, or when the rapid introduction of new inventions or developments can be counted upon to add new departments, or to change existing processes and methods. Yet competent employees grow impatient if more compensation and added responsibility do not come to them at the rate deserved. This

creates a difficult situation for both the business manager and his employees.

This American idea of more money and more responsibility for each year of service dates to expansion periods. All of us would like to see this cycle kept in balance because it builds better men, but how shall we overcome fundamental economic handicaps to its success, and how shall we improve the attitude and keep the enthusiasm of our employees when they are becoming more or less fixed in their economic position?

This is true despite the fact that business faces a new social and political situation today. The human factor is announced by political powers to be the dominating consideration in all industrial undertakings. The yardstick for measuring values in our present civilization is taken to be the well-being of the individual. This preferential position given to employees by law presents problems to both employers and employees. Leaders of industry have gone along developing large enterprises, multiplying the jobs for labor, applying power and machinery, stimulating the demand of the public for new products and, in general, making more goods at lower cost. They have thought that this program, together with the force of competition and the incentive for profit, leads to the most desirable social and commercial progress.

As a part of this plan industry considered its personnel as a foundation and sought to improve the economic position of employees through selling more goods at lower costs, so that purchasing power and wage rates could increase. And a firm part of this policy was a reward to the individual worker who showed ability above his fellows.

Employees on their part accepted this policy and sought to improve their economic position through meritorious achievement. Each man was more or less imbued with the idea that he could become president of his company, if he had the talent.

Under the new conception both employers and employees are put under controls that tend to stifle individualism and force uniformity. Business leaders are regimented and made to act according to fixed laws, and the employees are fixed by law into classes wherein promotion is a question of seniority instead of one of merit.

Experience indicates that the general industrial policy as carried out in the past has been sound, but some abuses, a growing complexity in national affairs, and social idealism have brought into play political and social forces of magnitudes equal or greater than economic realities in many instances, and have forced business leaders to give priority to personnel in their evaluation of the factors that make or break their enterprises. Without regard to economic fact or to the differences in human beings, both employers and employees are being forced into groups with arbiters and rulers appointed by the state under legal instructions to base decisions on the human element in business as the first consideration. Whether this is good or bad policy is a matter of opinion, but it does put upon both employers and employees new rules that may or may not fit economic conditions.

Present economic forces are already powerful to hold

industries to a slow growth, such as the large capital investments involved in expansion, and the years of effort required to get channels of distribution and trained employees established to sell products to the markets. Size and complexity work against the elasticity that is necessary to the expansion in numbers and the growth of rewards for employees. To these existing handicaps to building men into superior positions is now added the recent social legislation that makes employers and employees play the business game according to new rules.

Undoubtedly the first effect of the new laws is to slow up business expansion and to routinize the handling of personnel. Later, these laws, passed to prevent abuses, may not prove vitalizing tools for employers and employees

to use to bring about business success. In seeking to train men for the needs of tomorrow any industrial manager can but guess what these new forces will do to his plans and programs. No one can say what the future holds, but no one can stop business action.

Thus it is a fact, that we are dealing with new conditions and new forces that add to the complexity of business, and make it more necessary than ever for executives to use care in the selection and training of man power to fit into business needs. Business will go on. Executives in industry will still strive to get young engineering graduates and to train them. The more complicated business becomes, the more necessary will it be to get the best possible men and to train them with diligence.

The Paradox of Social Progress

By ROBERT E. DOHERTY

MEMBER AIEE

Courageously facing a startling and controversial subject, a prominent engineer and educator here voices some questions and makes some suggestions that merit consideration. Brief discussions are invited

I PROPOSE to examine the significance of some current thought and trends in our social, economic, and industrial life. My primary emphasis will center upon the relationship which research, engineering, and education bear to social progress and welfare. I trust it is unnecessary for me to disclaim gifts as a soothsayer, or intention to indulge in the idle lamentations of a Jeremiah, even if what I say does relate to the future and does perhaps bear a disquieting note. Merely, I would analyze what seem to be dominating factors in the problem of social progress and indicate their implications concerning what we as a people shall have to do if we are to achieve an adequate measure of intelligent control of the forces that shape that progress. This is precarious business, however, because it involves some generalizations as to what constitutes intelligent control, what constitutes prevailing opinion among economists, what constitutes present trends. Certainly there is not unanimity of opinion regarding any of these. Nevertheless, all serious-minded citizens, and especially those who have direct responsibilities in any of these mat-

ters, are under obligation to form clear convictions and give them expression, and this is my purpose.

We are told by the economists that to maintain prosperity and social progress within the profit system, it is necessary continually to increase the efficiency of industrial production; that is, to produce more goods at lower cost. But this process, which involves the full power of science, invention, and engineering, increases rapidly the complexity of social organization; and even now that complexity is growing faster than our social understanding. Hence we face the paradox that this very improvement of production which would save us from economic and social collapse would apparently also impel us ultimately to the same tragic fate. In other words, the remedy and the ill seem equally fatal.

What is the answer? Is there any way out of this paradox of social progress? Can we afford to throttle engineering and invention and thus run the risks the economists would predict? If not, dare we encourage technological progress even at its present rate, let alone at an accelerated rate, and take the risks of social and economic confusion to which it is evidently leading us? Is there no way out of this situation? I think there is.

A Proposed Remedy

It is planned education. I am confident that we as a people have at least the capacity, if only we would utilize

An address presented at the University of Illinois, Urbana, April 21, 1938, on the occasion of renaming the materials testing laboratory The Arthur Newell Talbot Laboratory.

ROBERT E. DOHERTY is president of Carnegie Institute of Technology, Pittsburgh, Pa. He was graduated from the University of Illinois in 1909, and was employed by the General Electric Company until 1931, when he became professor of electrical engineering, and subsequently dean of the school of engineering, at Yale University. In 1936 Doctor Doherty assumed his present duties. He received the 1937 AIEE Lamme Medal "for his extension of the theory of alternating-current machinery, his skill in introducing that theory into practice, and his encouragement of young men to aspire to excellence in this field" (EE, Mar. '38, p. 141; Oct. '38, p. 420-3).

it, to solve the problem by bringing up new professional generations who can learn how to cope with these increasing difficulties. Then we could encourage technology and look forward with confidence. The only question in my mind is whether the required changes can be brought about in time—that is, changes in professional point of view that must precede changes in educational programs.

Thus, my thesis may be stated in general terms as follows: I believe that this country faces a serious dilemma with social confusion as the apparent outcome of either choice; that this dilemma can be resolved to the end of democratic ideals only by the long and difficult process of a planned education that will require some fundamental changes in policy; and that delay in such changes and in instituting a revamped educational plan may prove fatal to its success.

Let us understand the first premise. When the economists say we must increase the efficiency of industrial production if we would maintain prosperity and make possible, at the same time, a rising scale of living, they are merely saying, if I understand them, that we can't lift ourselves by our bootstraps. For illustration, if an industry is operating in a balanced state—that is, if it pays its bills, its wages, and a reasonable dividend; if it keeps its plant and equipment in repair and provides those reserves which intelligent accounting control would specify; and if in doing these things it uses its whole income—then under this balanced state, the only way it can earn funds with which to meet any increase in expenditures, such as wages or taxes, is to produce its goods or service at a lower cost. If an industry is obliged, on account of government regulation, taxes, or the demands of labor, to destroy this balance, and the industry is not able for one reason or another to meet the added cost by increased efficiency, then the ultimate result is bankruptcy. The railroads today are a good example. The coal industry is another. And if we judge from the present move toward further federal regulation, the magnificent communication system of this country will, in due course, be still another. The economists therefore tell us with good reason that we must increase the efficiency of industrial production and, at the same time, keep new demands upon the industrial income within the new income thus created. This is our first premise.

Then we face the compelling force of our second premise that science and engineering, which we would encourage, are rapidly increasing the complexity of social organization beyond our understanding. There would naturally be little satisfaction in building further the magnificent technological structure already begun, and upon it an increasingly complex social structure, only to have the whole affair tumble down upon us. Although I must say if I had the choice between this fate, on the one hand, and, on the other, that of living in a doomed, defeatist world in which science and engineering were throttled down, I should choose the first. At least it would be more fun while we were at it. In any case, we face the evident fact that even with our present rate of technological development, the consequent growth in complexity of social relationships has already surged beyond our understanding.

Each day reveals fresh evidence of this. Most of the councils in which important matters of national concern are being settled are not distinguished by a comprehensive understanding of the problems considered and by rational thought. What does distinguish them are strategy, show of force, emotion, and oratory. This froth of words and cunning takes the place which reason and understanding should occupy. Witness, for example, conferences on the relief problem, the T.V.A. controversy, the conflict of labor with industry and of labor with itself, the N.R.A., the Supreme Court squabble with its incredible and demoralizing aspects. Any newspaper will afford further illustrations. Indeed the evident lack of understanding of the problems themselves is not the worst of it; many of the leading minds in these situations seem not even to comprehend the necessity of understanding the problems they are trying to solve. But you may say to me that technology is not wholly responsible for all of this confusion; that congenital stupidity adds its share, as it probably has done since primitive man began groping for practical readjustments to his changing environment. And I should agree. But in those early days the physical environment did not change rapidly. Man had infinitely more time in which to readjust his life and thought. What technology is responsible for is a tremendously accelerated tempo of change. We are not, in this age, dealing with the creeping advance of a glacier; we are dealing with the dash of an airplane and the speed of light. And if we do not learn how to anticipate essential readjustments and to bring them about intelligently and with necessary promptness, we probably shall crash. That is the burden of our second premise.

If we accept these two premises, are we not forced to the conclusion that if we would retain the fundamental elements of democracy, our only hope is a planned education—an education that would cultivate social and economic understanding, humane appreciation, and a scientific attitude of mind?

But I have no hope of Utopia. Even with such an education we should unquestionably still have our troubles. There must always be controversy; there must always be stupid people who have a hand in affairs; and moreover the problems of social organization will, it seems clear, become more and more complex just as surely as time goes on. However, I should hope that the fruits of such an education might make it possible for us to grope our way out of an inevitable succession of crises by having here and there a thread of intelligent purpose to guide us, and here and there a person who could detect and follow it. Thus perhaps at least a general direction could be imparted to the clumsy, milling masses of a now confused democracy.

May we assume then that a planned education, supported by both technological and social research, promises to be a way out? If so what form should this take?

We should bring up new professional generations who can continue technological progress, who understand social relations and organization, who comprehend the effects of their work upon society, and who have arrived at a philosophy that is in harmony with the ideals of democ-

racy. The acquirement of such a philosophy and such a social understanding must naturally be expected of all professional groups, and certainly of none of them less than of engineering. However, my observations from this point on will bear primarily upon engineering, concerning which I feel some degree of competency to speak.

To our purpose, then, there are two equally important sides of the engineer's education. One is technological; the other social.

Technological Education

On the technological side the implications are clear. In the first place the student's program must be *increasingly* directed toward better understanding of fundamental principles of science and engineering, and toward greater ability in the processes of analytical and constructive thought. I stress *increasing emphasis* on both of these because there is, and must continue to be, progressive extension in both depth and area of scientific knowledge, and a commensurate extension in its engineering applications. The developments that advance the technological frontier no longer spring from clever inventions that rest on an elementary knowledge of science and the experiences of everyday life. Rather they depend upon deep knowledge of an expanding science that can be mastered only by long, painstaking study and research. Compare, for instance, the development of the early steam engine, cotton gin, and telegraph, with that of the modern high-pressure steam turbine, the radiobroadcasting system, the new coaxial telephone cable (involving a single circuit over which more than 200 conversations may be transmitted simultaneously), the airplane, and automobile. These miraculous developments of contemporary science and engineering are fruits of research, invention, and analysis that rested upon profound scientific knowledge. And future generations will go still deeper. Recognizing this, engineering education in undergraduate years must place more and more emphasis on fundamentals, thorough understanding, and constructive thinking; less and less upon details of subject matter and specialized skills. The latter can be learned in graduate work or on the job.

Another reason for turning increasingly to fundamentals is the problem of time. Engineering curricula are already loaded heavily with technical matters, and there is now pressure to add another year to the curriculum in order to load on more. This pressure must be reversed, because, as I shall indicate presently more time must be assigned to the essential task of cultivating a social understanding and humane appreciation. Whether or not another year is necessary for this new task is yet to be demonstrated. I do not think that it is. In any case, however, an appropriate time—say one-quarter of the total curriculum—should be allocated to the task. This will press the technical side of the program within still narrower time limits and hence press the major emphasis still further toward fundamentals.

This change in emphasis and distribution of time will be difficult to achieve for two reasons. First, many employers will have to change their minds. They must be

willing to accept graduates who are more broadly educated and thus better equipped for the long run, but who must learn on the job some of the manipulative skills they now have upon graduation. And second, the faculty will have to change its mind. Each one of us on a faculty naturally is clear that his own course and everything in it are essential to a sound engineering education. Yet, however difficult the change may appear to be on both counts, it apparently must be made if the ends we seek are to be attained.

In proposing such change of emphasis I am not unmindful of the fact that many engineering graduates, perhaps the majority, will not participate directly in the pioneering side of scientific progress. They will be engaged in commercial and industrial activities for which a program cut out on the pattern of present curricula may be appropriate, but with the important exception that more time would be devoted to the social and economic side which I shall presently consider. This group of graduates is just as important, their work just as essential, to national progress as any other. Merely it is different. Also I am not unmindful of the practical problem of segregating student groups and of the increased cost. But these are secondary problems. The primary problem is to bring up professional generations appropriately prepared for the jobs and the responsibilities of citizenship that are ahead of them. And certainly one of the most important of these jobs is professional engineering leadership, and there must be appropriate programs for this in undergraduate, graduate, and post-college years.

Another implication of the plan on the technological side is increased facilities for research and education. There must be laboratories, and they must be supported by adequate staffs and equipment. The ideal type of laboratory for an educational institution is, in my opinion, one which houses under the same roof the research projects of staff and graduate students and also the exercises of undergraduates. Then the younger students are in contact, even if it is incidental, with the search for new scientific truth; they sense the thrill of accomplishment; they breathe the atmosphere of inspiration.

Social Education

Let me now draw your attention to the social side of the engineer's education. If his work creates wealth and physical comforts for society, but endangers social stability, then he ought to be more fully aware of what he is doing, its consequences, its dangers. His creative effort has been aimed at the development of higher speeds of travel and production, greater concentration of physical power, more efficient and extensive communication; it should now be aimed also at a more orderly adaptation of these developments to the social organization.

Indeed the engineer's professional place in society has rapidly become a very important one. He has been literally flung into industrial management and other responsibilities where social and economic elements are dominant, and he has had to learn to deal with these new responsibilities while on the job and with no fundamental

preparation such as he had had in engineering itself. On that side of management involving the cold facts of machinery, materials, and dollars and cents, I think we should all agree that he has been supremely successful; but not so on the human and social side. Yet his part on this side, both professionally and as an educated citizen, must become larger with time. I am not one who says it is the engineer's mission to save the country, but I am one who says that if it is to be saved, he must have a very definite hand in it. And he therefore must have an opportunity while in college to begin his educational preparation for this responsibility.

For his interest in these social changes and his ability to understand them will not come by chance. As a student he must begin to cultivate this interest and ability. Then when he encounters social problems he will at least have a start toward competency in studying them. Then he would be less likely to attempt to place human emotion in a simple formula or on a curve; he would be less likely to be persuaded by the lure of economic panaceas like technocracy or the rubber dollar; and he would realize that human affairs and social problems are even more complex than the ones he has dealt with in the physical world. He would be aware that there are extremely few simple relationships in the social sciences that stay put as do Ohm's law or Newton's laws of motion with which he has commonly dealt. And he would realize that instead of resting on rigid, permanent principles such as these, many social arrangements rest upon a philosophy that may shift, and shift quickly. What is right today may be wrong tomorrow.

These complexities are baffling to the student of physical science, because he attempts to use his rigid technical procedures to unravel them. One of the greatest educational fallacies I know is the assumption that the ability to solve problems in the field of physical science implies such ability in social and economic affairs. Indeed the reverse is probably true. When I was dean of engineering at Yale I urged students to take a course that has gained a national reputation—Human Relations in Industry given by Professor Elliott Smith. He told me that if possible I should send to him only juniors, not seniors, because he had found conclusively, year after year, that it took him two or three months longer with the seniors to break down the technical shell in which their minds were becoming enclosed; that their acquired habit of determining every problem with quantitative exactness had inhibited progress on the problems of his course which involved matters that could not be so determined. However this may be, I am clear from first-hand experience with engineering students who have undertaken to deal with social problems and from personal observation in industry that technical proficiency does not imply proficiency in dealing with problems involving human or social elements. The application of the scientific method in such problems requires something more. It requires knowledge of social evolution; it requires humane appreciation; and it requires an understanding of the difference between a philosophic doctrine and a physical law, and of the fickleness and power of human emotion. Without these, a keen

scientific mind becomes naive when it meets a social problem.

How can the social side of the engineer's education be accomplished in the limited time? I am clear that it cannot be done by offering electives in the conventional subject-matter courses such as English, government, economics, history, and the like. Even if the entire curriculum were assigned to such credit-hour units, thus eliminating engineering, I still should not believe that the student could acquire the integrated, historical view of social development, the scientific attitude, and the ability to analyze complex problems in the field of social relations that we have considered. At least if one is to judge by the current professional contributions of those who pursued such a program when they were in college and now have public responsibilities in these matters, one is not impressed by the effectiveness of that educational plan. I am sure there must be a more effective approach, at least in the education of engineers.

I hope I shall not be misunderstood when I say the approach to the educational problem should be an engineering approach. By this I mean simply that we should define the problem in terms of the outcomes of intellectual accomplishment with which we would have the student emerge at graduation, and then set about designing, first, a program every hour of which throughout the four years would be aimed accurately at the achievement of those outcomes, and, second, a means of testing *at the end* whether those outcomes have been achieved.

Thus, for this side of the engineering curriculum I would recommend for all engineers a four-year program, consuming perhaps a fourth of the total educational time, that would lead to the following outcomes: (1) a clear historical understanding of the parallel growths of science and engineering, on the one hand, and social customs, relations, and institutions, on the other, and of how these have reacted on each other—in other words, a social consciousness and a historical perspective of social evolution, especially, but certainly not wholly, since the invention of the machine; (2) the ability to read purposefully in order to make a critical analysis of a problem involving social and economic elements and to arrive at an intelligent opinion about it; (3) the ability to organize thoughts logically and with purpose; (4) the ability to use the English language and thus express those thoughts effectively; and (5) a continuing interest in all these matters—in other words, the desire to become educated.

Then there should be a new approach in research. To interested observers on the side-lines the point of view of social and economic research appears to have become, like much of that in education, so specialized and the research itself so desultory that progress toward understanding such phenomena as a whole is seriously inhibited. However, whether the scholars and specialists in the several fields concerned would agree wholly with such observers' impression, no one, I dare say, would disagree with the proposal that more research programs should be organized in which the distinguishing characteristic was continuing study and the breakdown of departmental barriers; programs, in other words, in which a continuous effort was

made by research teams to understand social relationships as a whole and how these are affected by technological progress. This research is, of course, primarily the responsibility of social scientists, but engineers most certainly have an interest in it.

Stated in still other words, the programs should attempt to draw unbroken trunk lines of the parallel growth of technology and the social structure, from early beginnings down to and extending into the living phenomena of the present. They should be an integration as well as a search for new facts. Specific studies have been made by a multitude of investigators on labor relationships, the results of labor-saving machinery, employability, housing, racial relations, social security, cost of living, etc., etc. And such factual studies have been necessary of course to provide segments of the lines of growth referred to above. But all of the factual segments have not been provided, and, more important still, their positions in the lines have not been established. The lines are yet to be clearly drawn. And finally, the programs should be continuous: unrelenting scientific pursuits of the problem. Fundamental scientific results are less likely to issue from studies limited to a few months or a few years than from a continuous program with long-range objectives. The results of such research should be fed into educational programs and thus contribute to general understanding.

Application to All Professions

But I do not wish my thesis to become obscured by the details of educational and research procedures. I have attempted to emphasize what seems to me a critical situation, a dilemma facing this country, and to suggest a possible, even if very difficult, resolution of it. Social trends are apparently leading us toward social chaos. Economists tell us that this chaos is inevitable unless technology is encouraged so that the efficiency of industrial production can be increased. Yet chaos seems equally certain if technology is encouraged, because it increases beyond our understanding the complexities of social relations and organizations. Our only hope, it seems, is a planned education. We must cultivate social understanding and humane appreciation among all of the professions, and especially is this necessary for engineers who have the double responsibility of technological development and social welfare.

I have said the solution is difficult. Effective public understanding cannot be realized by a mere handful of broadly educated men; large numbers of them are necessary. There must be not only those who serve the general welfare directly in their professional capacities, but untold others who, as citizens that have had the opportunity of higher education, will give critical thought and support to measures initiated for the public good. The education of such a professional citizenry is a long-range process. But this is not the fundamental difficulty. Neither is the difficulty a lack of national wealth from which the proper development of research and education might be supported; nor is it that we are divided into political pressure groups; nor that there is not sufficient inherent intellectual

capacity among our people. The fundamental difficulty is inducing mature minds to take a new view. Yet this must be done first of all. A new decision must be reached by the American people through their statesmen in politics, industry, finance, and education. It is the decision whether or not they are willing to pay the necessary double price for this program: the cost in money for new research and educational facilities; and the intellectual effort required in order to establish the educational policy just outlined.

Nevertheless, great as this double price may appear, the inevitable alternative price is infinitely greater. I mean the sacrifice of freedom. There are certain things to which we must cling at all costs. We must keep intellectual freedom; we must keep individual personal liberty to the greatest possible degree; we must keep incentives to constructive effort. These tongue-worn phrases still symbolize the American Dream. They represent ideals for which great sacrifices already have been made in life, treasure, and change of view. And it is unthinkable that as trustees of these gifts we should fail in the decision and action that would preserve them. I have said we as a people must make a decision. I have no fear that, given plenty of time, we should not make the right decision; I do have fear that under the now greatly increased tempo of life we may wait too long. The fundamental difficulty in our solution is complacency in professional America, a tendency toward frozen, or jelled, mental states. Will professional men on whose shoulders this responsibility rests, act in time? Or will the natural ossification of view as we reach the age of professional decision prevent our taking the initial step that is necessary before the younger generations, yet in college, can have the opportunity to prepare themselves?

Graphical Field-Plotting Methods in Engineering

TO EXHIBIT the great range of problems that may be solved with comparative ease by graphical means, even though they may be very difficult to solve analytically, is the object of this paper.* The most familiar examples of field plotting are used for solving the Laplace equation $\partial^2 v / \partial x^2 - \partial^2 v / \partial y^2 = 0$, solutions of which are known as "harmonic" functions. This equation, as well as its three-dimensional analogue, has a wide range of application, and receives more comprehensive treatment than does any other type of equation.

Succinct analyses of axially symmetric fields, plane fields in current-carrying regions (the Poisson equation), torsion of shafts of constant cross section, viscous flow in pipes, and torsion of shafts of circular but variable cross section make up the remainder of the paper.

* Abstract of 1938 AIEE summer convention paper number 38-59, by Hillel Poritsky, which will be published in full in *TRANSACTIONS*.

Influence of Utensils on Heat Transfer From Range Units

By W. GEORGE SHORT

USE of electricity for cooking has increased rapidly, largely because of the cleanliness, safety, and ease of control of the electric range. In a previous investigation,¹ W. James Walsh studied the heat-transfer efficiencies of various range surface units. He did not, however, investigate in detail the effect of various cooking utensils on the heat-transfer efficiency.

In the present investigation, the heat-transfer efficiencies of the various cooking utensils, when used on different range surface units, were studied in detail. The transfer of heat from the unit to the contents of the utensil can take place by conduction, by radiation, or by both. It is apparent, therefore, that the type of range unit, and the material and shape of the utensil, will influence the transfer of heat from the range unit to the utensil's contents.

Range Units and Utensils Used

The range units used in this investigation are shown in figure 1, and will be referred to as units A, B, C, and D. Each unit is rated at 1,200 watts, and each was tested when installed in the particular electric range with which it was designed to be used. The units and ranges were of the most modern type available at the time the tests were performed.

The utensils used in this study are included in figures 2 and 3. These represent not only conventional utensils, but also, the extremes from black-bottomed aluminum to glass. With transparent glass utensils, the contents are heated partly by radiation; with the other utensils used, however, all of the heat reaches the utensil either by conduction or radiation and must pass through the utensil to the contents by conduction.

The base of the glass utensil was, as indicated in figure 3, slightly smaller than that of the other utensils tested. Its dimensions were such that it did not cover completely the range unit as did the other utensils; however, the sides flared out permitting additional radiant energy to be absorbed. The black-bottomed aluminum utensil used was one of conventional type coated, by the manufacturer, with a black lacquer for these heat-transfer investigations, and is not available commercially. Attention is called to the fact that apparently very little is known regarding the efficiencies of the various types of blackening materials.

As indicated in figure 3, one of the enamel-ware utensils was made with a bottom of black enamel both inside and outside. The sides were of light-green enamel. The stainless-steel utensil of figure 3 was surfaced with a "satin finish" in contrast to the "polished finish."

Many different types of cooking utensils and electric range surface units are available for domestic use. The heat-transfer efficiencies of various combinations of utensils and units are different, as shown in this article, and from the standpoint of over-all efficiency of heat transfer, differences as great as 24 per cent have been found.

It may also be noted in this same figure that the bottom surfaces of the glass and of the steel containers were not flat, so that the entire surfaces could not be in direct contact with the range unit.

The handles of the aluminum and the black-bottomed enamel-ware utensils were removed during the tests, since they were not integral parts of the utensils.

The specific heats, weights, and capacities of the various utensils are shown in table I.

Measurement of Energy Input to Range Units

During the tests the input of electrical energy to the range unit was measured with a calibrated portable induction test meter (rotating standard). A constant value of alternating voltage as indicated by a voltmeter was maintained on the range unit during each test. Both the potential leads of the test meter and those of the voltmeter were

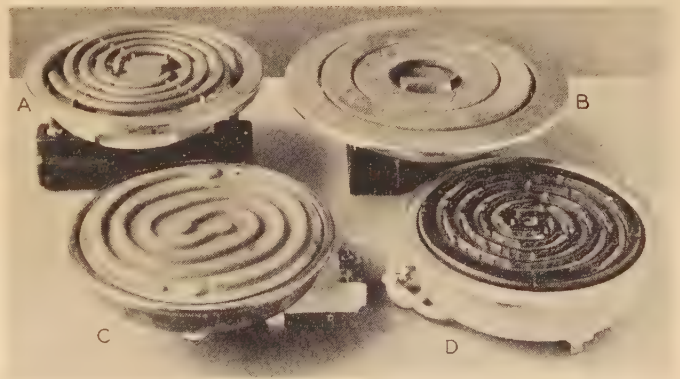


Figure 1. Range units used in investigation—rated 1,200 watts

connected directly across the range unit. An investigation showed that the error caused by the presence of the test meter was negligible, but that a correction was necessary for the energy consumed by the voltmeter. Measurements of time were made with an accurate stop watch.

From the observations made, the energy input W_t in calories is given by the equation¹

$$W_t = 860.4 (K_h R - E^2 t / 3600 r) \quad (1)$$

An article based on a paper presented at a joint meeting of the AIEE Portland Section and the Oregon State College Branch, Corvallis, Ore., May 15, 1937.

W. GEORGE SHORT, when the paper was prepared, was a senior student in electrical engineering at Oregon State College, from which he was graduated with the degree of bachelor of science in electrical engineering in 1937. He now is with the General Electric Company, Schenectady, N. Y.,

1. For all numbered references, see list at end of article.

Table I. Specific Heats, Weights, and Capacities of Utensils

Utensil	Specific Heat	Weight (Grams)	Rated Capacity (Quarts)
Black-bottomed aluminum.....	0.216.....	430.5.....	2.0
Bright-bottomed aluminum.....	0.216.....	418.8.....	2.0
Black-bottomed enamel.....	0.17 (approx.)..	991.2.....	3.0
White enamel.....	0.17 (approx.)..	475.5.....	2.0
Stainless steel.....	0.22.....	403.2.....	2.0
Glass.....	0.017.....	659.3.....	2.0

Table II. Heating Time Required for a Rise in Temperature of 75 Degrees Centigrade of Utensil Contents

Cooking Utensil	Time (Minutes)			
	Unit A	Unit B	Unit C	Unit D
Black-bottomed aluminum....	9.2.....	11.4.....	12.5.....	13.1
Black-bottomed enamel.....	9.6.....	13.0.....	12.9.....	13.4
Bright-bottomed aluminum....	9.8.....	11.9.....	14.6.....	15.9
Stainless steel.....	10.0.....	11.4.....	13.8.....	15.2
White enamel.....	10.8.....	13.9.....	14.2.....	14.1
Glass.....	11.8.....	16.1.....	16.0.....	15.2

where K_h is the constant of the test meter in watt-hours per revolution, R is the revolutions of the test meter, E is the voltage impressed on the unit, t is the time in seconds during which the unit is energized, and r is the resistance in ohms of the voltage coil.

Measurement of Energy Transfer to Utensils

For these measurements the general method and precautions described¹ by Walsh were followed, and the same calibrated resistance thermometer was used for temperature measurements. Equal amounts of water (1,250 grams or 2.76 pounds) were used in each utensil

The energy W_o in calories transferred from the range unit to the utensil and the water it contained is given by the formula

$$W_o = (C_p W_p + C_w W_w)(T_2 - T_1)$$
 (2)

where C_p is the specific heat of the utensil, W_p is the weight of the utensil, C_w is the specific heat of the water, W_w is the weight of the water, T_1 is the temperature at the start of the tests, and T_2 is the temperature at any time during the test period.

Calculations of Efficiencies of Heat Transfer

The efficiency of heat transfer from the element to the contents of the utensil is the ratio of the energy input to the contents divided by the energy input to the range element. That is, the heat transfer efficiency in per cent is the ratio of the energy as given by equation 2 to that given by equation 1, or

$$\eta = W_o / W_i \times 100$$
 (3)

This value is the *over-all efficiency*¹ from beginning to end of the test.

The *instantaneous efficiencies*,¹ which take into considera-

tion the input and output at a given instant only, may be obtained from input-output curves by determining the slope of those curves at each point. Mathematically, the instantaneous efficiency is

$$\eta = dW_o / dW_i \times 100$$
 (4)

Fundamentally, equation 4 consists of the ratio of two time rates of change, that of the input and of the output. Walsh has compared¹ these two efficiencies to the all-day and instantaneous efficiencies of a transformer.

Experimental Procedure

In general, the experimental procedure¹ perfected by Walsh was followed in this study. One important exception was the method used to prevent excessive evaporation from the surface of the water in the utensil during the tests. Much trouble was experienced by Walsh in obtaining a uniform film of Apiezon oil over the water surface. In these tests, therefore, a sheet of waxed paper, cut to fit closely the inside of the utensil, and pierced for the thermometer leads, was used. A small quantity of Apiezon oil was placed around the edges and the thermometer leads to make a better seal.

From the experimental data, the *over-all* efficiencies were calculated as discussed in a previous section. The *instantaneous* efficiencies were obtained from input-output curves. These efficiencies are the slopes of the curves at any point. These slopes were determined by the use of the "mirror rule" or "tangent meter" described by Schweitzer.²



Figure 2. Bright- and black-bottomed aluminum utensils



Figure 3. Black-bottomed enamel, white-bottomed enamel, stainless steel, and glass utensils

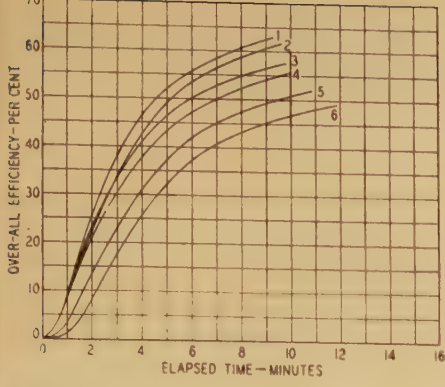


Figure 4. Type A unit

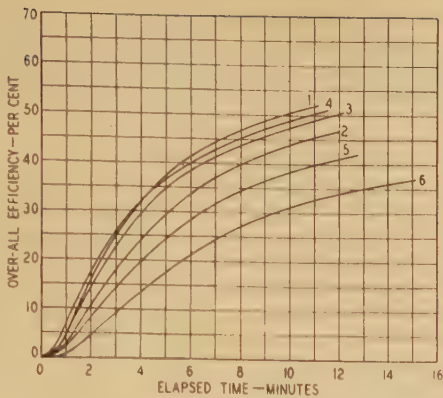


Figure 5. Type B unit

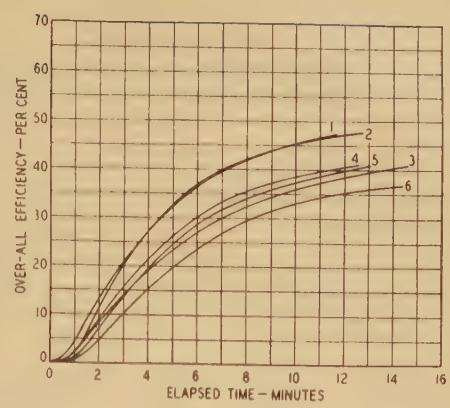


Figure 6. Type C unit

Figures 4-7. Over-all efficiencies of electric range surface units used with several types of utensils

Unit at room temperature at start of test
Weight of water 1,250 grams or 2.76 pounds

- 1—Black-bottomed aluminum
- 2—Black-bottomed enamel
- 3—Bright-bottomed aluminum
- 4—Stainless steel (satin finish)
- 5—White enamel
- 6—Glass

Results of Tests

The results of the heat-transfer efficiency tests on the various cooking utensils and range units are summarized by figures 4 to 7 and accompanying tables, which indicate the variations in transfer efficiency for each utensil on each range unit.

The speed of each utensil when used on the various range units is indicated in table II. As a measure of the speed or heating time of each combination, the time required for a rise in temperature of 75 degrees centigrade of the contents of the utensils was arbitrarily chosen.

In table III are shown the over-all efficiencies for a 75-degree-centigrade temperature rise in the contents of each

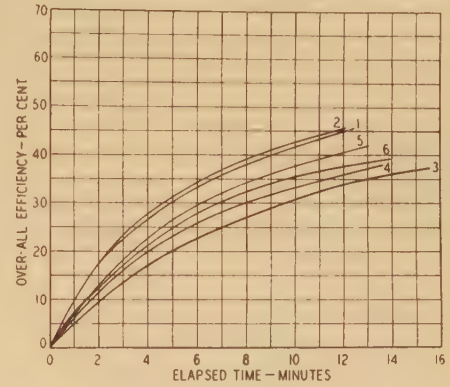


Figure 7. Type D unit

Table III. Over-all Efficiency for a Rise in Temperature of 75 Degrees Centigrade of Utensil Contents

Cooking Utensil	Over-all Efficiency (Per Cent)			
	Unit A	Unit B	Unit C	Unit D
Black-bottomed aluminum	62.7	52.0	48.0	46.5
Black-bottomed enamel	61.6	48.0	47.5	47.5
Bright-bottomed aluminum	57.5	50.0	41.0	37.5
Stainless steel	55.7	51.0	41.5	40.0
White enamel	52.0	43.0	42.0	43.5
Glass	49.1	37.5	37.5	40.5

Table IV. Maximum Instantaneous Efficiencies for Each Combination of Utensil and Range Unit

Cooking Utensil	Maximum Instantaneous Efficiency (Per Cent)			
	Unit A	Unit B	Unit C	Unit D
Black-bottomed aluminum	76.8	65.0	58.2	58.1
Black-bottomed enamel	74.5	53.6	60.0	53.1
Bright-bottomed aluminum	70.5	63.5	51.7	49.2
Stainless steel	68.0	56.0	50.0	40.0
White enamel	66.5	47.8	50.0	53.3
Glass	61.5	49.9	47.8	46.6

utensil when used with the various range units. These values were taken from figures 4, 5, 6, and 7 by applying the heating-time values of table II to these figures and noting the corresponding over-all-efficiency values. These values are comparable to the watt-hour input to each combination to obtain the same temperature rise with the same contents in the utensil. All other factors being disregarded, the over-all efficiency is the true measure of the efficiency of each combination.

The maximum instantaneous efficiencies obtained on each range unit with each different utensil are summarized in table IV. The maximum instantaneous efficiency values are the limiting values approached by the over-all efficiencies of figures 4 to 7.

Discussion of Experimental Results

Since the purpose of this investigation was to study the efficiencies of various utensils and range units, the experimental results will be discussed for these combinations, rather than for the utensils and range units separately. It is, therefore, convenient to summarize the results of tables II, III, and IV in table V.

A brief explanation of this table will now be given. Referring to column A of table II it may be seen that the contents of a black-bottomed aluminum utensil on range unit A reached a temperature rise of 75 degrees centigrade in a shorter time than any other combination. The black-bottomed enamel utensil was second in heating time, the bright-bottomed aluminum utensil was third, and so on. The utensils are accordingly arbitrarily rated in table V in

that order, when used with range unit *A*. This element operated at a high temperature and accordingly transmitted heat to the utensil both by conduction and radiation.

The ranking of the various utensils as to heating time on range unit *B* is included in the corresponding column of table V. The black-bottomed aluminum and the stainless-steel utensil had the same heating time, and were both given "first" ratings, second place being omitted. Unit *B*

Table V. Summary of Characteristics of the Various Combinations of Cooking Utensils and Electric Range Units

Cooking Utensil	Heating Time With Range Unit:				Over-all Efficiency With Range Unit:				Instantaneous Efficiency With Range Unit:			
	A	B	C	D	A	B	C	D	A	B	C	D
Black-bottomed aluminum.....	1	1	1	1	1	1	1	2	1	1	2	1
Black-bottomed enamel.....	2	4	2	2	2	4	2	1	2	4	1	3
Bright-bottomed aluminum.....	3	3	5	6	3	3	5	6	3	2	3	4
Stainless steel.....	4	1	3	4	4	2	4	5	4	3	4	6
White enamel.....	5	5	4	3	5	5	3	3	5	6	4	2
Glass.....	6	6	6	4	6	6	6	4	6	5	6	5

is a low-temperature range unit, and the fact that the black-bottomed aluminum and the stainless steel utensils had identical heating times shows that this unit transmits but little heat by radiation.

Range unit *C* operates at a higher temperature than does *B*, and again the results indicate that transfer by radiation occurs. This is further brought out by the open-wire unit *D*. With this unit much heat transfer apparently takes place by radiation through the glass utensil and directly to the contents as the last item indicates. It is significant that the black-bottomed aluminum pan has the shortest heating time on all units.

The over-all-efficiency ratings of table V are obtained from table III. These efficiency ratings also show the superiority of black-bottomed utensils on units such as *A* which operate at high temperature. The general superiority of the black-bottomed aluminum utensil is again apparent.

Similar conclusions can be drawn from the instantaneous efficiency ratings. Again the advantage of black-bottom utensils on high-temperature units is evident, as is also the general over-all superiority of the black-bottomed aluminum utensil.

A general figure of merit or a resultant rating for each utensil is possible from table V. Thus, if all the ratings of each utensil on the various units are added, and this sum is then divided by the number of ratings, such a figure of merit is obtained. These combined ratings are as follows: black-bottomed aluminum, 1.17; black-bottomed enamel, 2.42; stainless steel, 3.67; bright-bottomed aluminum, 3.83; white enamel, 4.17; and glass, 5.5. In this classification, a low number indicates a general superiority of the cooking utensil for all electric range work irrespective of the type of range unit with which it is used. This applies, of course, only to the utensils and range units tested. These are, however, representative of the types

available commercially. Furthermore, the comparisons of table V apply only when the units are consuming full wattage; that is, with the range switch on high.

Conclusions

Cooking utensils combining optimum conduction and radiation heat-transfer properties result in higher transfer efficiencies with the various range units. Differences in over-all efficiencies as great as 24 per cent were found between the best and poorest utensil and range unit combinations. The economic aspect of this is apparent.

For highest heat-transfer efficiency, the bottom of the cooking utensil and the top of the range unit should at all times be in intimate contact. To accomplish this, the bottom of the cooking utensil should be flat, and should not warp during use on the range element.

These tests indicate that with units operating on intermediate and low positions of the range switch, utensils which are especially designed to absorb energy by radiation and conduction should not show transfer efficiencies much greater than those which absorb energy largely by conduction alone.

References

1. HEAT TRANSFER EFFICIENCY OF RANGE UNITS, W. James Walsh. ELECTRICAL ENGINEERING, volume 56, August 1937, pages 953-8.
2. THE TANGENT METHOD ANALYSIS FOR INDICATOR CARDS OF INTERNAL COMBUSTION ENGINES, P. H. Schweitzer. Bulletin No. 35, Pennsylvania State College, September 1926.

Absolute Power Factor of Air Capacitors

STANDARD air capacitors are used with measuring equipment of high sensitivity for comparison with test capacitors in investigations such as the study of dielectric materials; therefore the absolute power factor of the standard should be known. In the investigation reported in this paper,* seven air capacitors of different types of construction were studied. A method of determining the absolute power factor of an air capacitor was developed, and data were obtained on the effects produced by the degree of polish of the electrode surfaces, by the width of gap between the measuring electrode and its guard ring, and by the presence of water films on the plates.

Experimental results showed that in an air capacitor with brass plates whose surfaces are clean, dry, and free from oxides and dust, the absolute power factor is independent of the voltage stress up to 50 volts per mil, varies inversely with separation between plates, is not affected by the roughness of the surface, and is independent of the width of the gap between guard ring and measuring electrodes. High atmospheric humidity was found to increase the power factor even when the capacitor was enclosed in a substantial metal box.

* Abstract of 1938 AIEE summer convention paper number 38-96, by W. B. Kouwenhoven (F'34) and E. L. Lotz (A'38), which will be published in full in TRANSACTIONS.

Graphics in the Solution of Complex Quantities

By E. C. GOODALE
ASSOCIATE AIEE

IN THE solution of a-c network problems there are two common methods of attack. In one the system is reduced to its equivalent impedances, and in the other to its equivalent admittances. The electrical quantities of a series circuit are determined most simply by finding first the impedances of the parts that are in series, then solving for the common voltage (if it is not given) and for the voltage drops. A multiple circuit is solved most simply by expressing it in terms of its admittances, then solving for the currents in the branches. If combinations of the

equal to the sum of the characteristic angles of the two quantities. The absolute value of their complex product therefore is $|z_a| \cdot |z_b|$ and intersects the base line at an angle $(a + b)$ degrees, where $a = \tan^{-1} (x_a/r_a)$ and $b = \tan^{-1} (x_b/r_b)$.

Figure 1 shows a simple graphical multiplication of z_b by z_a . Lay off r_a along the reference line, and at the tip of r_a lay off x_a in its proper relationship to r_a , thus determining point A on the diagram. With OA as a temporary reference line, lay off r_b along OA and draw x_b in its proper position with respect to r_b , determining point B . Along

Figure 1. Graphical solution of the complex product of two impedances Z_a and Z_b .

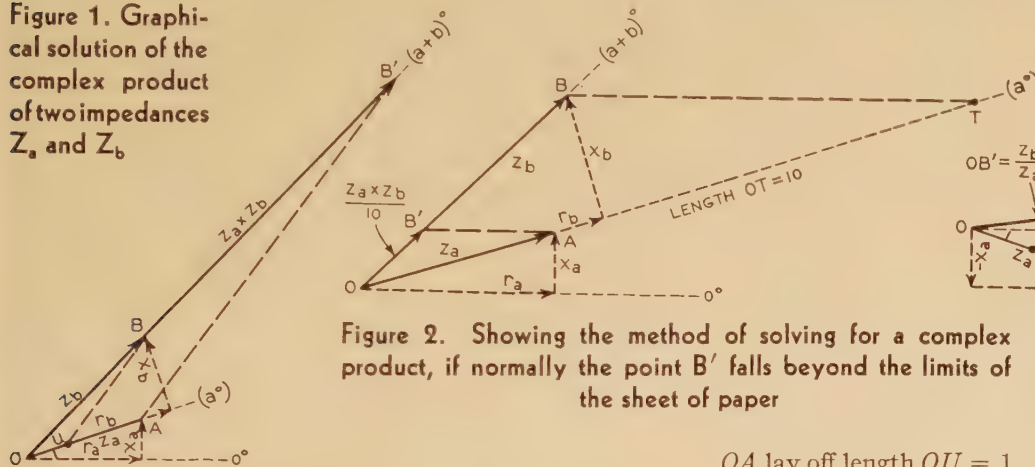


Figure 2. Showing the method of solving for a complex product, if normally the point B' falls beyond the limits of the sheet of paper

two types of circuits are involved, the solution is simplified by using either all impedances or all admittances.

This may be done graphically, and certain well-known simplifications or equivalent networks may be solved graphically, without the necessity of the usual multiplication and division of complex quantities in solving the equations.

The process described here applies to the multiplication and division of complex quantities by graphical means, the only tools, aside from paper and pencil, being a straight-edged rule and a compass. It involves no trigonometric tables, and protractors are unnecessary, although a protractor or 90-degree "T" mark on a triangle is useful in laying off the 90-degree relations.

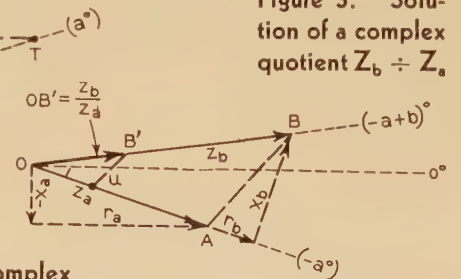
Multiplication of Complex Quantities

Consider two complex quantities $z_a = r_a + jx_a$ and $z_b = r_b + jx_b$. In accordance with the established rules of the algebra of complex quantities, their complex product is equal numerically to their numerical product and lies at a characteristic angle, with respect to the reference line,

Based upon a prize paper "A Graphical Method of Multiplying and Dividing Complex Quantities and Its Uses in the Solution of Impedance Networks," presented before the AIEE Seattle Section, March 28, 1938, at a prize paper meeting.

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Figure 3. Solution of a complex quotient $Z_b \div Z_a$.



OA lay off length $OU = 1$. Draw UB . From A draw AB' parallel to UB and intersecting produced OB at point B' .

From the similar triangles OUB and OAB' ,

$$OB'/OA = OB/OU \text{ or } OB' = OA \cdot OB/OU$$

Therefore

$$OB' = z_a z_b / 1$$

It is evident from figure 1 that the line OB' lies at an angle $(a + b)$ degrees with respect to the reference line. If the construction of figure 1 throws point B' off the paper, then instead of unit point U , lay off along OA , or OA produced, a longer line $OT = 10$, as in figure 2. Draw TB . From A draw AB' parallel to TB and intersecting OB at point B' . Length OB' is one-tenth the product $z_a z_b$. Therefore, when this construction is used, the length OB' should be multiplied by ten. In a similar way any desired multiplier may be adapted to the diagram, whatever the range of values covered by z_a or z_b .

Division of Complex Quantities

Figure 3 shows z_b of figure 1 being divided by z_a . By established rules for the division of complex numbers, their complex quotient is numerically equal to their numerical quotient, and has a characteristic angle equal to that of the dividend minus that of the divisor. For figure 3 this angle is $(b - a)$ degrees. At right angles to the reference

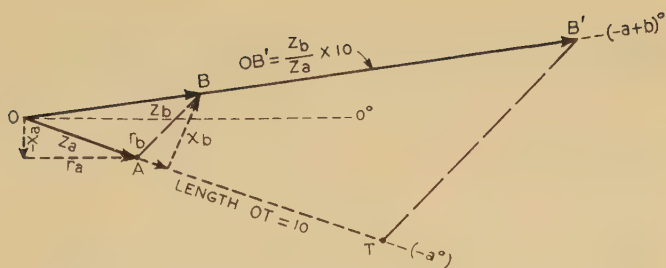


Figure 4. This type of graphical solution may be used to magnify the quotient line of a complex division by any desired amount, if normally it would be too small to interpret accurately

line lay off $-x_a$, and from the tip of $-x_a$ lay off r_a parallel to the reference line, thus determining point A. With OA as a temporary reference line, lay off r_b along OA and x_b in its proper position with respect to r_b , determining point B. Along OA lay off $OU = 1$. Draw AB. From point U draw UB' parallel to AB and intersecting OB at B' . From the similar triangles OAB and OUB,

$$OB'/OU = OB/OA$$

Therefore

$$OB' = OB \cdot OU/OA = z_b/z_a$$

If the construction of figure 3 throws point B' too close to O, then instead of the unit point U, lay off along OA or its extension length $OT = 10$ (or any other convenient multiple) as in figure 4. Draw AB. Draw TB' parallel to AB, to intersect OB or its extension at point B' . Length OB' is ten times the quotient z_b/z_a ; therefore, divide the length OB' by ten, or by whatever multiplier may have been used for OT.

Where complex numbers are arranged in the form of a multiplication and a division, as in the expression $z = z_a z_b / z_c$, it is possible to simplify the multiplying and dividing operation by using any desired length as reference distance in place of the unit distance. It will clarify the diagram to take one of the quantities, such as z_c , as a reference distance.

A Simple Application

Although this graphical method may be extended to embrace the analysis of rather complex networks, its convenience and simplicity may be demonstrated adequately by the solution of a relatively simple circuit. Consider, for example, a circuit consisting of two impedances Z_a and Z_b in multiple. The single equivalent Z of such a combination is determined by the well-known expression $Z = Z_a Z_b / (Z_a + Z_b)$, where all quantities are complex. This means that the numerator is equal to the numerical product of Z_a and Z_b , and the denominator is the vector sum of Z_a and Z_b . The characteristic angle of Z is $(a + b - c)$, where $a = \tan^{-1} X_a/R_a$; $b = \tan^{-1} X_b/R_b$; and $c = \tan^{-1} (X_a + X_b)/(R_a + R_b)$, with respect to the reference line.

Figure 5 shows the graphical solution for Z , the single equivalent of the two impedances $Z_a = 5 + j3$ and $Z_b =$

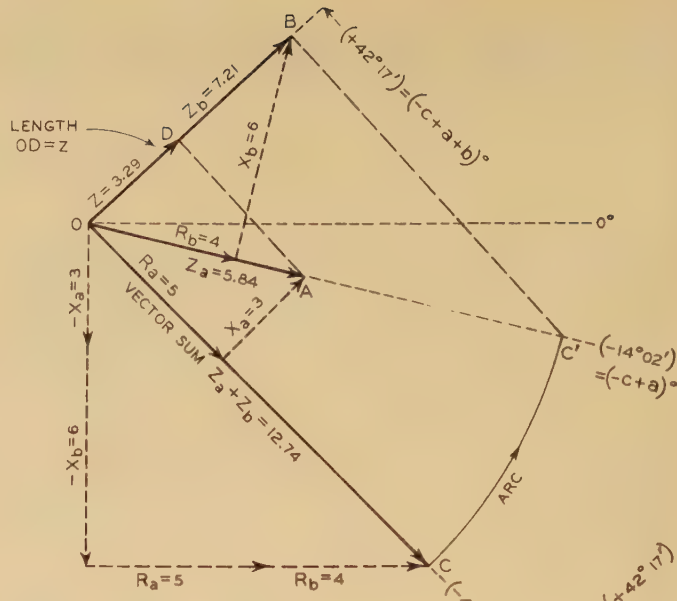
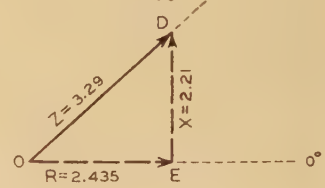


Figure 5 (above). Determination of the single equivalent Z of two impedances in parallel

Figure 6. Resolution of impedance Z of figure 5 into its components R and X



$4 + j6$ in multiple. Lay off $-X_a$ and $-X_b$ at an angle of -90 degrees with respect to the reference line. Then, parallel to the reference line, lay off R_a and R_b , as shown. This determines point C. Length OC is equal numerically to the vector sum of Z_a and Z_b and lies at an angle of $-c$ degrees with respect to the reference line.

With OC as temporary reference line, lay off R_a along OC and X_a 90 degrees ahead of OC to determine point A. OA is equal numerically to Z_a and lies at an angle of $(-c + a)$ degrees with respect to the reference line. With OA as temporary reference line, lay off R_b along OA and X_b 90 degrees ahead of OA to determine point B. Length OB is equal numerically to Z_b and lies at an angle of $(-c + a + b)$ degrees with respect to the reference line.

With O as center and radius OC, describe arc CC' cutting OA produced at C' . Draw $C'B$. Draw AD parallel to $C'B$ and intersecting line OB at point D. Length OD then is equal to Z , the single equivalent of Z_a and Z_b in multiple, and it lies at the correct characteristic angle $(-c + a + b)$ or $(a + b - c)$ degrees with respect to the reference line. Figure 6 shows the resolution of Z into its quadrature components, R its equivalent resistance, and X its equivalent reactance. From D draw DE perpendicular to the reference line. Then length OE = R and length ED = X . The construction of figure 6 usually would be made on the diagram of figure 5. It was omitted there in order to make figure 5 clearer for the main construction.

Both reactances in the multiple circuit were assumed to be inductive. Had one reactance been capacitive, its direction in the diagram would have been exactly the reverse of those taken by the inductive reactances in figure 5.

Sterilization by Ultraviolet Radiation

By SAMUEL G. HIBBEN
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THROUGHOUT the entire range of the electromagnetic or ether spectrum, from radio wave lengths 20 miles long to the minute lengths of 0.0001 Angstrom impinging upon the earth from interstellar space (the Angstrom being a wave-length linear distance of one ten-millionth of a millimeter, or approximately four billionths of an inch) man has developed the means of producing and exactly recording all the various radiations except those termed the cosmic rays or those that may consist of rapidly pulsating energies having wave lengths of the order of 0.01 Angstrom or less (figure 1). The analysis and the synthesis of radiation stretching far to both sides of the visible or rainbow spectrum (to which the eye is attuned) has been one of the most admirable contributions of physical science. The knowledge of these energies is not recent, but the practical applications thereof to human needs and human services has expanded rapidly in the last few decades, and seems destined to expand still further since the subject is receiving a concentration of attention in modern research.

One of the most intriguing regions now being intensively explored is generally classified as the subvisible or ultraviolet portion of the spectrum, extending generally from the 4,000-Angstrom wave length of deep purple (visible) light to the shortest wave lengths that may be transmitted through fused quartz, or for any reasonable paths through air. Since the limit of quartz transmission is roughly 1,700 Angstroms and of air but slightly shorter, we may assume that the region under practical consideration extends from extremely long X-ray radiations, perhaps 1,000 Angstroms, up to the beginning of retinal sensitivity.

While it is true that the term "ultraviolet" is applied to this entire portion, yet recent knowledge has suggested the division of ultraviolet radiations into four portions, not sharply defined as to wave-length limits, but rather classified in accordance with the peculiar and quite differing properties. The simplest form of this division is as follows:

Fluorescent or near ultraviolet.....	4,000 to 3,300 Angstroms
Biologically effective or erythral region.....	3,300 to 2,800 Angstroms
Abiotic or sterilizing region.....	2,900 to 2,000 Angstroms
Ozone-producing region.....	2,000 Angstroms to limits of air transmission

A new use for electricity rapidly is developing in the field of sterilization through controlled applications of radiation in limited portions of the ultraviolet spectrum. Such radiation has been known sketchily for its abiotic properties, but a practical knowledge leading to commercial applications has evolved only recently from careful segregation of different wave lengths, the elimination of certain very short-wave radiations that seem undesirable, and the perfection of a means of measuring such radiation quantitatively. The sterilization of foods and food containers, various utensils, and articles subject to mold or fungi growths, and the reduction of air-borne bacteria seem destined to characterize this new tool in the form of commercial tubular lamps as one of man's strongest instruments in combating disease and reducing spoilage losses.

The latter two portions, or radiation having wave lengths shorter than about 2,900 Angstroms must be man-made—such radiations do not reach the earth's surface from the sun. The third portion, or the abiotic region, is the one that challenges our immediate attention since the radiations of these wave lengths when properly applied can aid quite definitely in the prolongation of human life and in the betterment of living conditions.

The lethal effects on microorganisms and fungi constitute the distinguishing property of such radiations, and the job that is being done today en-

compasses the perfection of a technique whereby nature can be aided in man's fight against disease, and whereby certain economic losses, especially in the handling and storage of food products, can be reduced. History is likely to record that the development of a simple practical means of destroying bacteria was one of the most important contributions of electrical engineering to the well-being of man.

When properly applied, short-wave radiation unquestionably does kill bacteria rapidly, and destroys the spores of fungi and often the fungus itself if it is superficial.¹ An index of the destructive power on certain microorganisms is given by figure 2,² showing that the minimum energy, or the greatest effectiveness, is with radiation of about 2,600 Angstroms in wave length, and that the required amount of energy rises tremendously when radiations much longer than some 2,900 Angstroms are used. Under the impact of the peculiar energy there appears to be a coagulation of plasma, surface blistering, and disintegration as represented by the conditions of paramecia shown in figure 3.

Based upon an address presented originally at a meeting of the AIEE Ithaca Section, November 5, 1937; subsequently revised and brought up to date.

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P. W. BLACKBURN is in the special products engineering department, lamp division, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., supervising laboratory production of developmental electronic devices and peculiar radiators.

1. Koch 1889; Henri 1912; Newcomer 1917; Bayne-Jones and Van der Lingen 1923; Gates (reports of Rockefeller Foundation) 1929, 1930. See other references in Laurens "The Physiological Effects of Radiant Energy," 1933.

2. Gates, Harvard University Research, Rockefeller Foundation; see Laurens "Physiological Effects of Radiant Energy," 1933.

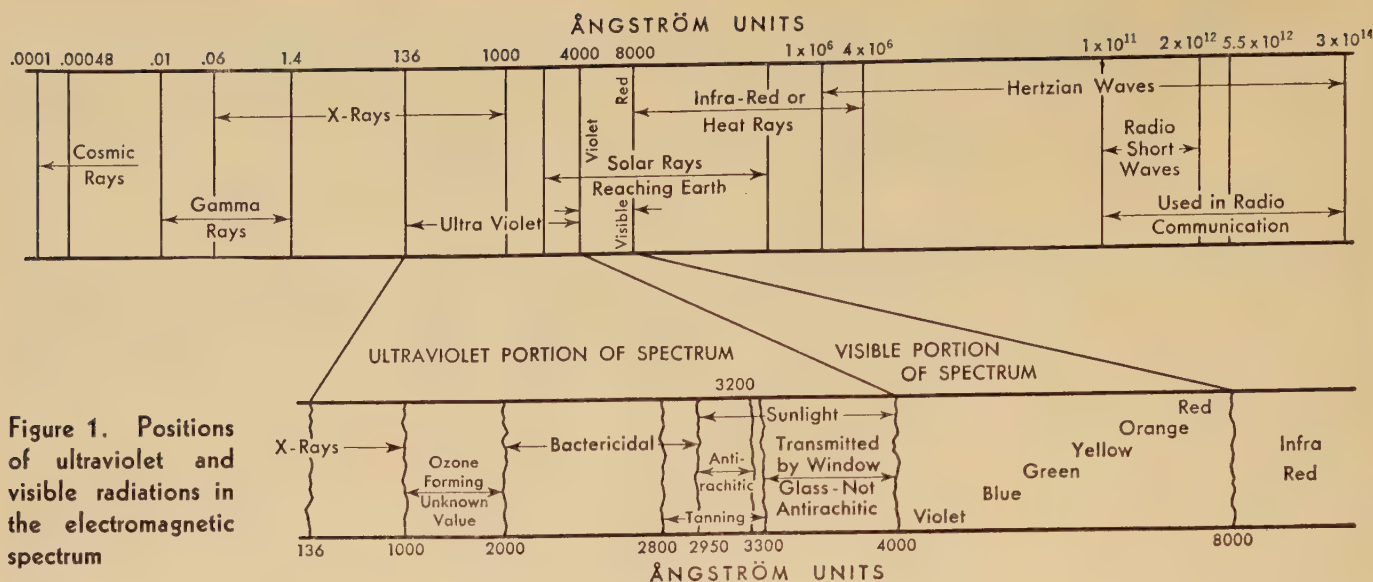


Figure 1. Positions of ultraviolet and visible radiations in the electromagnetic spectrum

The choice of the quality of radiation is critical. This can be appreciated better when we recall the entirely different colors of *visible* radiation, or light, and note that all the rainbow colors are produced by wave lengths that in the extreme will differ by but some 35 hundred-thousandths of a single millimeter! Sensuously, blue light is decidedly different from green, yet on the wave-length scale the difference is a seemingly negligible five hundred-thousandths of an inch! Thus, radiations having but the slightest wave-length differences may have quite varied properties physiologically.

Since abiotic or bactericidal radiation in any appreciable concentration is screened away from the earth's surface in the transmission of sunlight through the atmosphere, we must resort to an artificial production through the ionization of gases or vapors. One of the most practical methods is to develop an electric arc or discharge through mercury vapor at very low pressure in a glass tube or suitable container (figures 4 and 5) and emitting selected wave lengths needed for the particular job at hand. One such commercial device recently introduced under the trade-mark "Sterilamp" emits more than 80 per cent of its radiant energy at the wave length of approximately 2,600 Angstroms, and hence is a very potent and practical tool.

Energy of this wave length, at the low concentration found in the proper installation, will not penetrate the human skin sufficiently to bring about any known physiological effects. Under prolonged exposures (Laurens, Rentschler) there may be slight pigmentation or tan, and a highly concentrated overdose will produce erythema, but differing from normal sunburn. Conjunctivitis is the chief thing to guard against if working close to an exposed source, but ordinary glass protects the eyes adequately.

The Sterilamp consists of an evacuated tube some one-half inch in diameter and of varying lengths (figure 5) into the ends of which are sealed special metallic electrodes coated with such electron emitting material as barium and strontium oxides, designed to minimize voltage drop.

Into the tube is inserted a small quantity of inert gas, or a mixture of gases, which permits ionization at normal room temperatures and thus allows the arc discharge to become established instantaneously when the electric power is applied to the tube terminals, and at reasonable voltage. This starting voltage is in general also a function of the tube length, ranging in the commercial product from some 400 to 800 volts.

In addition, the tube contains mercury vapor at a pressure of from four to ten millionths of an atmosphere—a pressure which results in the emission of a negligible amount of radiant energy in the visible spectrum but produces the well-known ultraviolet mercury lines, chiefly the 2,537- and 3,650-Angstrom wave lengths. The quality of the special glass of this lamp is carefully selected so as to obtain maximum transmission of wave lengths longer than some 2,000 Angstroms (65 per cent at 2,537 Angstroms) but to absorb rather definitely such shorter wave lengths as the 1,850- and 1,940-Angstrom bands.

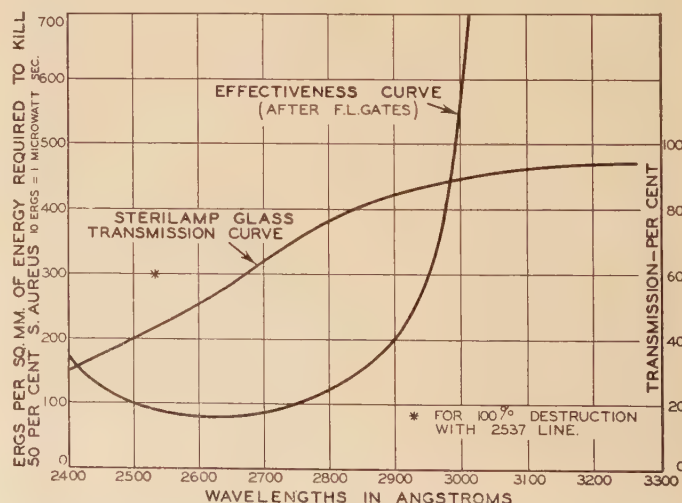


Figure 2. Typical abiotic effectiveness curve of ultraviolet radiation (Gates: report of Rockefeller Institute) and transmission curve of special glass used in Sterilamp tubes

Table I. Characteristics of Some Commercial Ultraviolet Radiators

Over-all lengths, maximum, inches.....	14 1/2.....	24 1/2.....	34 1/2.....
Effective lengths, inches.....	10.....	2.0.....	.30.....
Maximum diameter, inches.....	7/8.....	7/8.....	7/8.....
Lamp shape.....	Straight tube.....		
Starting volts, a-c.....	400.....	575.....	750.....
Operating volts, a-c.....	275.....	375.....	475.....
Operating current, amperes.....	0.03-0.05.....	0.03-0.05.....	0.03-0.05.....
Burning position.....	Any.....	Any.....	Any.....
Effective life.....	Six months of service.....		

One of the problems has been to limit the amount of radiations known to react on the atmosphere (oxygen) to produce ozone. This gas in turn may react unfavorably on the membranes of the nasal passages, or have a toxic effect, or may be absorbed by certain materials such as fats and hasten oxidation, or develop objectionable odors and rancidity. It will prevent the transmission of 2,537-Angstrom radiation. Neither are wave lengths much longer than 3,000 Angstroms useful, because such are not as abiotic or would be required in much too great a volume to do the same kind of work as the radiations of shorter wave length.

For the majority of the conceivable applications of short-wave radiation, an excess of energy should be avoided lest the surfaces of nearby objects, especially some food products, might become in a sense cured or "sunburned," or lest the by-product of radiated heat might be objectionable as in air-conditioned or refrigerated spaces. Hence it has been logical to restrict the ultraviolet lamps to a low power consumption, usually about six watts per foot of tubing. Moreover, the small diameter of the arc stream relative to its length, and the carefully chosen mercury-vapor pressure, restricts to a negligible amount the output having wave lengths longer than the strong 2,537-Angstrom band. The commercial lamps normally consume 0.03 to 0.05 ampere, or an average of 35 milli-amperes. A 20-inch tube operating at 375 volts thus may consume approximately 12 watts, with the temperature of no part rising more than five to ten degrees centigrade

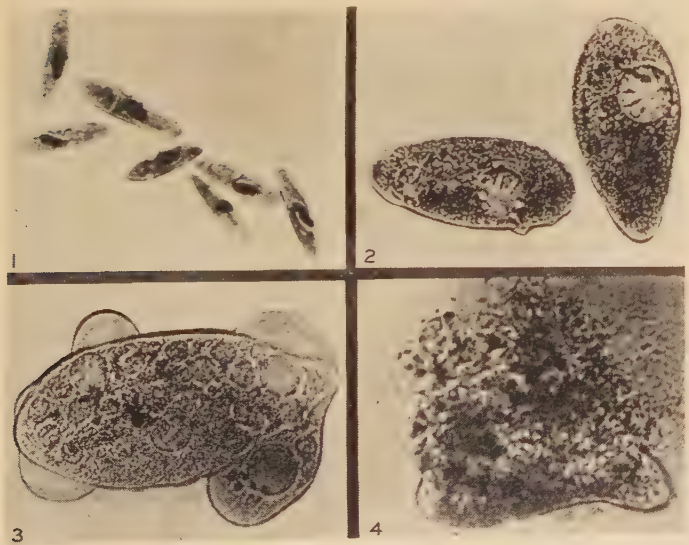


Figure 3. Photomicrographs showing successive phases in the disintegration of paramecia when irradiated

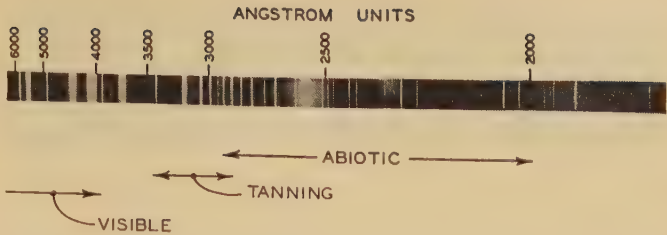


Figure 4. Mercury-arc spectrum showing wave lengths of visible (light) and ultraviolet radiations emitted

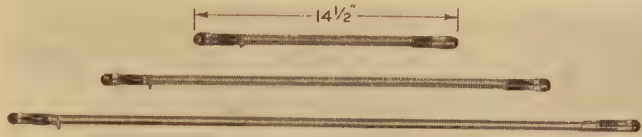


Figure 5. Three common sizes of Sterilamps to produce short-wave radiation

above the ambient temperature. The energy emitted in the visible spectrum is of a pleasant light blue color but negligible for any illumination purposes. At some 18 inches from a typical tube the illumination is no more than one foot-candle.

Since the menace of bactericidal infection or the propagation of mold may be continuous, it is expected that in the majority of installations the sterilizing radiation will be made available continuously, or at least during all working hours. In reducing air-borne bacteria in auditoriums, schools, or offices the sterilization process normally would continue during hours of occupancy, in the endeavor to keep the germ count at least as low as would exist outdoors. In the case of food storage as in a refrigerator, the radiation would be advisable 24 hours daily. Such usage has led to the design of commercial lamps for a useful life of the order of 4,000 hours, or six months of continuous burning.

The volume of ultraviolet emission from any particular unit or group of tubes may be controlled by varying the current input through a change of transformer taps, or by the number of tubes in series on one transformer. An uncontrollable influence is that of very cold surrounding air since a condensation of mercury vapor (the pressure approximately 0.4 micron at zero degrees Fahrenheit) normally will reduce ultraviolet output. The vapor pressure is optimum and the radiation is most abiotic when the wall temperature of the lamp is slightly in excess of 45 degrees Fahrenheit. The lamp is designed so that at refrigerated-air temperatures of some 40 degrees Fahrenheit or higher, the output is satisfactory.

As with any gaseous-discharge lamp, these tubes possess negative resistance, requiring a current-limiting device to be used in series. Since the lamp requires a transformer that will deliver a voltage high enough to start the discharge, the current-limiting feature can be incorporated into one unit. From one to four lamps may be operated in series from the secondary of such a transformer, although naturally the current through each tube will vary with the number of tubes. Since the open-circuit second-

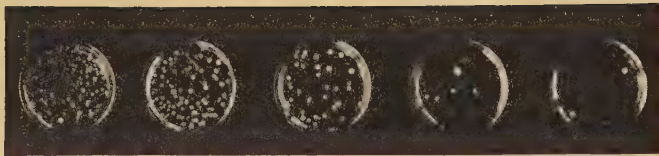


Figure 6. Effectiveness of Sterilamp in killing bacteria

The plates have been exposed to the ultraviolet radiation of the Sterilamp for varying lengths of time, then incubated until the remaining bacteria grew into colonies large enough to be photographed as white dots. The durations of exposure, in seconds, were, left to right: 0, 1 1/4, 2 1/2, 5, and 10

ary voltage in a cold-cathode lamp may be in excess of 1,000 volts, it has been advisable to develop deep porcelain sockets to protect the metal ends of the lamps and to supply a power unit in which is incorporated an under-current relay to de-energize the primary circuit upon any interruption of the lamp circuit. For stability of operation, the voltage drop across the lamps represents approximately two-thirds of the equivalent supply voltage.

When dealing with extra-short-wave radiations, reflecting and absorbing materials must be chosen critically. Polished or oxidized aluminum is practically the only suitable reflector, with a coefficient of some 60 per cent at 2,600 Angstroms. Chromium is about equally as efficient. Most ordinary glasses are opaque. Some of the fungi or spores can be killed through several inches of clear water, but for bactericidal purposes the penetration in slightly turbid liquids is extremely shallow.

Many months of careful and at times hazardous experimentation with toxic germs and untried wave lengths of energy have evolved an interesting technique that has been predicated upon an exact quantitative measurement of the abiotic radiation. Until recently this measurement has been the missing link. However, when the tantalum photoelectric cell was perfected, this having much the same wave-length response to ultraviolet radiation as the lethal action of these radiations upon bacteria, it became a simple process to tabulate scientifically the abiotic energy necessary to kill any chosen microorganism. Thus in the future sterilizing installations will be planned with an exactness equalling that of the normal lighting installation, and the ultraviolet meter becomes the "brother" of the foot-candle meter.

Numerous circumstances will influence results; but on a comparative basis if 1,000 units of abiotic radiation are required to kill black mold, then to kill other organisms the following ratios exist:

Black mold (<i>Aspergillus niger</i>).....	1,000
<i>N. catarrhalis</i>	60-85
<i>B. subtilis</i>	25-30
<i>E. coli</i>	15-20
<i>E. typhosa</i>	7-10

It appears that most of the common bacteria, such as found on the rims of drinking glasses, when reached by direct radiation such as applied by one 30-inch tube at a distance of from three to six inches, will be destroyed in approximately two minutes. Table II gives typical data in the sterilization of drinking glasses (figure 6).

One of the broad fields where sterilizing radiation is

Table II. Results of Sterilization Tests on Drinking Glasses

Location	No. of Tests	Before Irradiation	After Irradiation, Two Minutes	
		No. of Colonies	No. of Colonies	Per Cent Improvement
Inside rim.....	20	2,122	10	99.2
Outside rim.....	20	4,342	59	99.0
Inside bottom.....	20	3,492	42	99.0
Inside rim.....	17	3,000	25	99.0
Outside rim.....	17	1,732	3	99.3
Inside bottom.....	17	1,274	18	98.6
Inside rim.....	15	917	6	99.5
Outside rim.....	15	631	23	96.3
Inside bottom.....	15	103	13	87.3

applicable is in the preservation of fresh meat (figure 7). Refrigeration, even below 32 degrees Fahrenheit does not kill but merely inhibits the growth of mold and bacteria so that spots of mold and patches of slime caused by putrifying bacteria gradually develop and must be trimmed away before the meat can be sold. Furthermore, the lower the temperature the more difficult it becomes to maintain the humidity in the refrigerator and prevent loss in weight of the meat from dehydration.

It has been found that two 30-inch lamps, consuming a total of less than 25 watts, are sufficient to prevent mold growth and putrefaction in the seven- by nine-foot cooler used by the average retail meat dealer. The temperature can be raised up to but not exceeding 45 degrees Fahrenheit, which usually permits higher relative humidity with less dehydration loss. If the air in the cooler is cir-



Figure 7. Maintaining sterile air by ultraviolet radiation in a meat storage room; note ultraviolet (U.V.) tubes near ceiling

culated by a fan, no mold or bacterial growths appear even on the surfaces of the meat not directly exposed to the radiation!

The baking industry is another field where the sterilizing lamp has been used with marked success. The room where the dough is held for yeast reaction must be kept warm and moist, conditions likewise favorable for the growth of mold. Although the baked goods are sterilized during the baking, they become recontaminated during the cooling, slicing, and wrapping processes by the mold spores carried by air currents from the dough room. Lamps mounted on the ceiling of the dough room prevent the growth of mold therein, yet since the rays do not penetrate the dough, do not interfere with the yeast reaction. As an added precaution, lamps are mounted in the cooling room or over the cooling conveyors so as to protect the product from contamination until it is wrapped. This technique greatly extends the mold-free life of baked goods.

Air sterilization is perhaps the largest field for ultraviolet radiation. The lamps have been used successfully to reduce the air-borne organisms in hospital operating rooms to prevent infections and in the treatment of contagious diseases to prevent the infection of other patients. It has been found by Rentschler and James of the Westinghouse laboratories that an organism floating in the air is killed with perhaps one-tenth of the radiant energy required to kill that same type of organism once it has settled on an agar plate.

These are but a few of the applications of the sterilizing properties of ultraviolet radiation that have been investigated. Many more constantly are arising, and while no single installation is large, from the standpoint of power consumption, the diversity and universality of the applications suggest that the aggregate load will become a factor for future consideration. There is the further gratification in knowing that through making man's life safer and his economic losses less, the electrical industry is contributing another great benefit to civilization.

Stability Characteristics of Turbine Generators

THIS paper* reviews and analyzes the steady-state stability characteristics of turbine generators taking the effects of saturation into account. The need for such an analysis has become particularly important with the recent trend toward 3,600-rpm units of large capacity. With the development of such units, the designer is forced in the direction of reducing the weight of the rotor per kilovolt-ampere in order to keep the length and diameter within reasonable limits. However, the reduction in weight of the rotor tends to reduce the short-circuit ratio, which has long been used as a measure of the stability characteristics. The determination of the stability characteristics which may reasonably be expected from a

machine, and the validity of short-circuit ratio as a criterion for steady-state stability were considered important enough to justify an analysis. Although the paper deals primarily with the cylindrical-rotor type of generator, the results also apply in general to the salient-pole type.

Some of the general conclusions drawn from the results of this study are that a generator without voltage regulator may require a short-circuit ratio of at least 1.0 if it is expected to pick up full load from an initially lightly loaded condition with no change in excitation; that a generator remote electrically from its load should be equipped with a voltage regulator in order that the short-circuit ratio required need not be uneconomically high; and that the reactance of a turbine generator operating at 0.8 power factor overexcited, and provided with a reliable voltage regulator and excitation system, does not influence appreciably the static stability limit, but the limit is influenced considerably by a generator operating at 1.0 power factor near the static stability limit.

Symbolic Analysis of Switching Circuits

IN CONTROL and protective circuits of complex electric systems intricate interconnections of relay contacts and switches frequently are necessary. Examples of such circuits may be found in automatic telephone exchanges, industrial motor-control equipment, and in almost any circuits designed to perform complex operations automatically. In this paper* some of the properties of such networks are analyzed mathematically, and particular attention is given to network synthesis. If the circuit characteristics are given and the circuit incorporating those characteristics is to be found, the solution is not unique, and methods of finding those particular circuits having the minimum number of relay contacts and switch blades are described. Methods for finding any number of circuits equivalent in all operating characteristics to a given circuit also are outlined.

The general method used in this paper is somewhat unusual. Briefly, any circuit is represented by a set of equations, the terms of which correspond to the various relays and switches. The equations then are manipulated by means of simple mathematical processes, most of which are similar to ordinary algebraic algorithms. A special type of calculus is evolved for this use, and is shown to be exactly analogous to the calculus of propositions used in the symbolic study of logic. For synthesizing a circuit the characteristics are first written as a system of equations, then manipulated into the form representing the simplest circuit. From these equations the circuit may be drawn immediately. By this method it is possible always to find the simplest circuit containing only series and parallel connections, and in some instances the simplest circuit containing any type of connection.

* Abstract of 1938 AIEE summer convention paper number 38-98, by C. Concordia (M'37), S. B. Cray (M'37), and J. M. Lyons (A'28), which will be published in full in TRANSACTIONS.

* Abstract of 1938 AIEE summer convention paper number 38-80, "A Symbolic Analysis of Relay and Switching Circuits," by Claude E. Shannon (Enrolled Student), which will be published in full in TRANSACTIONS.

News

Of Institute and Related Activities

Southern District Meeting in Miami, November 28-30

FLORIDA offers extraordinary vacation possibilities to all who plan to attend the Southern District meeting of the AIEE in Miami, November 28-30, 1938. The Miami Biltmore Hotel has been chosen as headquarters because it offers an ideal combination of meeting facilities and recreational advantages, which permits relaxation between business sessions. For those who travel by car, many points of historical and scenic interest will be available en route. For those who come direct by rail, both organized side trips and individual trips by special parties will be available. Miami and Florida have many things that will both interest and amuse visitors.

SPORTS

At the disposal of members and guests at the headquarters hotel are all the equipment and grounds of the famous Miami Biltmore Hotel. Located on the grounds are fast championship tennis courts and a large outdoor swimming pool renowned for aquatic records which have been broken in its waters and from its diving boards. Also, on the grounds for use in the intervals between committee meetings and gatherings, are the 6,640-yard, 18-hole championship golf course upon which the Miami Biltmore open tournament is played each year, with its beautiful club house, and a bridle path for those who enjoy horseback riding.

Headquarters hotel guests also have the extraordinary privileges of the Florida year-round clubs. Those staying at the Miami Biltmore are granted temporary membership in these three sports clubs. First, there is the Miami Biltmore Country Club, adjoining the hotel, with a sporty, championship golf course and one of the most beautiful club houses in the country, with professional instructors. Second is the famous Roney Plaza Cabana Sun Club, Miami Beach, with a private beach, outdoor salt-water pool, lockers, tennis courts, tropic gardens, sun-bathing facilities, sidewalk cafe and an outdoor terrazzo dance floor in a grove of coconut palms. And third, there is the Key Largo Anglers Club, 48 miles south of Miami, on one of Florida's tropical "keys"—an island for informal living and sport-fishing.

Important to your personal budget is the unusual economy provided by the Miami Biltmore's fleet of "aerocars" which transport guests to all resort activities in this area without charge. These "aerocars," moving on rapid schedules, ply between the Miami Biltmore and Miami Beach, traversing the business and theater districts of

Coral Gables, Miami, and Miami Beach, to and from Key Largo and intermediate interests southward.

ENTERTAINMENT

Group luncheons are planned for members and guests on Monday and Tuesday. A banquet for students and members will be held Monday night, at which time student paper awards will be made. There will be a formal banquet Tuesday evening for all members, guests, and their families. In addition to the entertainment furnished to the women by the various sports, sightseeing and bridge have been arranged for their entertainment during the technical sessions. All should take their golf clubs, bathing suits, tennis rackets, or riding habits so that favorite pastimes can be enjoyed to the fullest extent.

TECHNICAL SESSIONS

Including the student session, four technical sessions will comprise the program. Monday morning will be devoted to registration and opening of the meeting followed by a lecture "Measuring Electrically." The afternoon session will be devoted entirely to student activities. Technical sessions Tuesday and Wednesday

mornings will deal with transmission, distribution, generation, and related problems, while Tuesday afternoon will be devoted to papers and discussions of education, economic, and sociological subjects.

SIDE TRIPS

Arrangements have been made for two- and four-day trips to Havana at nominal expense for those who would enjoy a trip to the Cuban capital after the meeting.

A trip to Key West over the recently completed Overseas Highway, and inspection of the Nine-Mile Bridge and Bahia Honda Bridge, unique in their engineering and structural features, will prove interesting to many guests. Built upon the right-of-way and trestles of the Florida East Coast Railway to Key West, which was so damaged in the 1935 hurricane that it no longer was used for rail travel, this highway traverses a route over tropical, colorful waters, and provides an unusual and interesting journey not to be found in other highway travel.

Arrangements also have been made for a trip from Miami to the sugar mill and farms of the U.S. Sugar Company in Clewiston. Guests who avail themselves of this trip not only will have an opportunity to view the sugar production industry, but will pass through the rich Everglades muck land section, in which much of the winter vegetable crop is produced, and may inspect the \$20,000,000 Lake Okeechobee dyke system which was completed in 1937. This dyke, 200 feet wide at the base and 20 feet at the crest, extending around approximately three-fourths of Lake Okeechobee, together with



Miami Biltmore Hotel from golf course

its system of locks and drainage gates, was constructed to prevent repetition of the enormous destruction of life and property which accompanied a hurricane over Lake Okeechobee in 1928.

Sightseeing trips over Miami, Miami Beach, Coral Gables, and all points of interest in the Miami area have been arranged, and each guest will have ample opportunity to become acquainted with the beauty of Miami.

RULES ON PRESENTING AND DISCUSSING PAPERS

Papers presented at technical sessions may be presented in abstract, presentation not to exceed ten minutes unless otherwise arranged, or the presiding officer may meet with the authors preceding the session to arrange the order of presentation and allotment of time for papers and discussion.

Any member is free to discuss any paper when the meeting is opened for general discussion. Ten minutes for prepared discussion and ten minutes for open discussion will be allowed on each paper. Those presenting written discussions will be selected from the various Sections in the Southern District. Open discussions are invited and all

members should feel free to enter into them.

It is preferable that a member who wishes to discuss a paper give his name in advance to the presiding officer of the session at which the paper is to be presented. Each discussor should step to the front of the room and announce, so that all may hear, his name and professional affiliations. Three typewritten copies of discussions prepared in advance should be left with the presiding officer.

Other discussions to be considered for publication must be submitted, typed double spaced, in triplicate to C. S. Rich, secretary, technical program committee, AIEE headquarters, 33 West 39th Street, New York, N. Y., on or before December 14, 1938.

HOTELS AND REGISTRATION

Hotel rates, including all privileges of Florida year-round clubs will be: single, \$3.50 to \$5; double \$6 to \$8. Meals at the hotel will be served at: breakfast 50¢ to \$1; luncheon 75¢ to \$1.25; dinner \$1.25 to \$2. Special rates for students have been obtained at the Casa Loma Hotel, adjacent to the headquarters hotel at \$1 per day with meals at \$1.70 a day up. Students in the

Casa Loma Hotel will have privileges of the swimming pool. Reservations should be made as soon as is practical by addressing the Miami Biltmore Hotel, convention department, Coral Gables, Fla.

Members who will attend the meeting and who have not already registered in advance are urged to do so promptly. This will be helpful to the committees and will permit badges to be made ready in advance, thus avoiding congestion at the registration desk. Please complete the registration promptly upon arrival at the meeting.

No registration fee will be charged members or their immediate families or Enrolled Students, but a registration fee of \$2 will be charged all nonmembers. Tickets for entertainment features will be available at the registration desk and all members and guests are urged to procure these tickets at the time of registration.

COMMITTEES

The personnel of the Southern District meeting committee is as follows: A. P. Michaels, *chairman*; E. D. Wood, *vice-president*, AIEE Southern District; A. S. Hoefflin, *secretary*, AIEE Southern District; E. E. George; E. F. Johnson; M. E. Lake; E. F. Smith; W. Austin Smith; and Joseph Weil. The chairmen of the subcommittees are as follows: J. Coleman Jones, *program*; J. B. Hiers, Jr., *finance*; J. D. Preston, *attendance and publicity*; P. J. Carlin, *transportation and inspection trips*; R. Y. Pool, *entertainment*; E. F. Johnson, *hotel and reservations*; and E. F. Smith *student activity*; W. Austin Smith, *papers*; and H. V. Street, *registration*.

Program

Photo-offset copies of authors' manuscripts, exclusive of addresses, may be obtained in advance of the meeting by writing to the AIEE Order Department, 33 West 39th Street, New York, N. Y. Only numbered papers will be available in advance-copy form. If ordered by mail, price 10¢ per copy; if purchased at Institute headquarters or at the meeting, price 5¢ per copy. Coupon books in \$1 and \$5 denominations are available for those who wish to avoid remittance by check or otherwise. Some of the papers ultimately will be published in ELECTRICAL ENGINEERING or the TRANSACTIONS.

Monday, November 28

Opening Session

8:30 a.m.—Registration
10:00 a.m.—Address of welcome
10:15 a.m.—Response and announcements
10:30 a.m.—Illustrated lecture: MEASURING ELECTRICALLY, Everett S. Lee, General Electric Company

12:30 p.m.—Group luncheons

2:00 p.m.—Student session

7:30 p.m.—Students' and counselors' banquet and student paper awards

Tuesday, November 29

9:00 a.m.—Technical Session

120. RURAL LINE PROTECTION UTILIZING CO-ORDINATED RURAL PROTECTIVE DEVICES, W. H. Rollman and F. J. Guice, Memphis Power and Light Company.

121. ELECTROLYSIS AND CORROSION OF UNDERGROUND METALLIC STRUCTURES, R. J. Kuhn, consulting engineer, New Orleans, La

122. LOADING TRANSFORMERS BY COPPER TEMPERATURE, H. V. Putman and W. M. Dann, Westinghouse Electric and Manufacturing Company.

123. LIGHTNING PROTECTION IMPROVEMENTS FOR TRANSMISSION LINES, Llewellyn Evans, Tennessee Valley Authority.

12:30 p.m.—General assembly luncheon

2:00 p.m.—Technical session

124. GRADING THE ENGINEER'S JOB, R. H. Kirkwood, Tennessee Valley Authority.

Address: MODERN ASPECTS OF ENGINEERING EDUCATION, Joseph Weil, University of Florida.

Address: THE SOUTHERN ENGINEER WEIGHS NEW PROBLEMS OF NEW INDUSTRY, Eugene O'Brien, *Southern Power Journal*.

Address: THE BUSINESS MAN LOOKS ON THE ENGINEERING GRADUATE, Kendall Weiseger, Southern Bell Telephone and Telegraph Company.

8:00 p.m.—Banquet and dance

Wednesday, November 30

9:00 a.m.—Technical Session

125. ELECTRICAL DESIGN OF PICKWICK LANDING PROJECT, E. P. Almond, Tennessee Valley Authority.

126. THE MULSFYRE SYSTEM FOR EXTINGUISHING OIL FIRES, K. P. Jones, Grinnell Corporation.

127. RECONDITIONING OF INSULATING OILS BY ACTIVATED ALUMINA, J. E. Housley, Aluminum Company of America.

128. SHOP PRACTISE IN THE REPAIR OF HIGH-VOLTAGE BUSHINGS, G. F. Stratton and W. L. Stratton, Armature Winding Company.

129. GENERATOR DAMPER WINDINGS AT WILSON DAM, R. B. George and B. B. Bessesen, Tennessee Valley Authority.

Treasurer Slichter Visiting South America

W. I. Slichter (A'00, F'12), head of the department of electrical engineering at Columbia University and national treasurer of the Institute, left New York, October 22, on an extended tour during which he will visit the principal coastal cities of South America and will skirt the entire continent before returning to the United States in January 1939. Treasurer Slichter expects to pay a visit to F. M. Servos (A'19, M'27), AIEE local honorary secretary for Brazil, during a stay of two weeks in Rio de Janeiro and São Paulo. He will attempt to see as many South American members of the Institute as possible, particularly in the Brazilian cities, and in Buenos Aires (Argentina), Santiago (Chile), and Lima (Peru). In each of these cities Professor Slichter expects to stay a week or more.

Annual Power Exposition. The Thirteenth National Exposition of Power and Mechanical Engineering, to be held at Grand Central Palace, New York, N. Y., December 5-10, 1938, is said to have attracted many exhibitors, and, according to the managers of the exposition, anticipation of improvement in business activity has stimulated manufacturers to increased interest in the exposition.

Nomination of AIEE Officers for 1939 Election; Members' Suggestions Invited Until December 15

FOR the nomination of national officers to be voted upon in the spring of 1939, the AIEE national nominating committee will meet during the winter convention, January 23-27, 1939. The officers to be elected are: a president, a national treasurer, three directors, and five vice-presidents, one from each of the even-numbered geographical Districts. Fellows only are eligible for the office of president, and Members and Fellows for the offices of vice-president, director, and national treasurer.

To guide this committee in performing its constituted task, suggestions from the membership are, of course, highly desirable. To be available for the consideration of the committee, all such suggestions must be received by the secretary of the committee at Institute headquarters, not later than December 15, 1938.

In accordance with the provisions in the constitution and by-laws, as amended during 1935 and quoted in the following paragraphs, actions relative to the organization of the national nominating committee are now under way.

Constitution

28. There shall be constituted each year a national nominating committee consisting of one representative of each geographical district, elected by its executive committee, and other members chosen by and from the board of directors not exceeding in number the number of geographical districts; all to be selected when and as provided in the by-laws. The national secretary of the Institute shall be the secretary of the national nominating committee, without voting power.

29. The executive committee of each geographical district shall act as a nominating committee of the candidate for election as vice-president of that district, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

30. The national nominating committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The national nominating committee shall name on or before January 31 of each year, one or more candidates for president, national treasurer, and the proper number of directors, and shall include in its ticket such candidates for vice-presidents as have been named by the nominating committees of the

respective geographical districts, if received by the national nominating committee when and as provided in the by-laws; otherwise the national nominating committee shall nominate one or more candidates for vice-president(s) from the district(s) concerned.

By-Laws

SEC. 22. During September of each year, the secretary of the national nominating committee shall notify the chairman of the executive committee of each geographical district that by December 15 of that year the executive committee of each district must select a member of that district to serve as a member of the national nominating committee and shall, by December 15, notify the secretary of the national nominating committee of the name of the member selected.

During September of each year, the secretary of the national nominating committee shall notify the chairman of the executive committee of each geographical district in which there is or will be during the year a vacancy in the office of vice-president, that by December 15 of that year a nomination for a vice-president from that district, made by the district executive committee, must be in the hands of the secretary of the national nominating committee.

Between October 1 and December 15 of each year, the board of directors shall choose 5 of its members to serve on the national nominating committee and shall notify the secretary of that committee of the names so selected, and shall also notify the 5 members selected.

The secretary of the national nominating committee shall give the 15 members so selected not less than 10 days' notice of the first meeting of the committee, which shall be held not later than January 31. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. All suggestions to be considered by the national nominating committee must be received by the secretary of the committee by December 15. The nominations as made by the national nominating committee shall be published in the March issue of ELECTRICAL ENGINEERING (Journal of AIEE), or otherwise mailed to the Institute membership not later than the first week in March.

INDEPENDENT NOMINATIONS

Independent nominations may be made in accordance with provisions in Section 31 of the constitution and Section 23 of the by-laws, which are quoted below:

Constitution

31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the national secretary when and as provided in the by-laws; such petitions for the nomination of vice-presidents shall be signed only by members within the district concerned.

By-Laws

SEC. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with Article VI, Section 31 (constitution), must be received by the secretary of the national nominating committee not later than March 25th of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the national nominating committee in accordance with Article VI of the constitution and sent by the national secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(Signed) H. H. HENLINE,
National Secretary

November 1, 1938

Chemical Industry Awards. W. S. Landis, of the American Cyanamid Company, New York, N. Y., has been elected to receive the Perkin Medal of the Society of Chemical Industry for 1939. The medal is awarded

annually for valuable work in applied chemistry, and will be presented this year to Doctor Landis for his work on cyanimid, derivatives of cyanimid, fertilizers, the first commercial production of argon, and contributions to the explosives industry. The medal will be presented at a meeting of the Society on January 6, 1939. The Chemical Industry Medal of the Society was presented to J. V. N. Dorr, of The Dorr Company, New York, N. Y., at a joint meeting with the American Chemical Society, November 4, 1938, in New York, "in recognition of his inventions and subsequent world-wide introduction of apparatus and processes in many chemical, metallurgical, and sanitation operations which have made possible low-cost production on a large scale."

Additional Committee Personnel Announced

A complete list of the Institute's officers and committees for the year 1938-39 was published in the September 1938 issue of Electrical Engineering, pages 397-99, with the exception of the technical committees on industrial power applications, transportation, and power generation. Announcement of the membership of these committees was made recently, and is presented here.

The listing of the committees is arranged in the same typographical style as the lists in the September issue, so that all who so desire may complete the previous lists by cutting out the following and pasting them in the appropriate spaces.

Industrial Power Applications

J. D. Wright, Chm., General Electric Company, Schenectady, N. Y.	
E. A. Armstrong	M. J. McHenry
R. F. Chamberlain	F. C. Nicholson
C. W. Drake	J. J. Orr
John H. Edwards	William A. Perry
E. Gordon Fox	D. E. Renshaw
F. E. Harrell	H. W. Rogers
L. C. Ilsley	F. O. Schnure
R. L. Kingsland	L. A. Umansky
A. E. Knowlton	R. L. Walsh
Carl Lee	R. H. Wright
	C. J. White

Power Generation

E. C. M. Stahl, Chm., Consolidated Edison Company of New York, Inc., 4 Irving Place, New York, N. Y.	
H. C. Albrecht	S. J. Lisberger
F. A. Annett	C. E. Magnusson
G. M. Armbrust	A. C. Monteith
W. L. Cislser	E. F. Pearson
C. A. Corney	G. G. Post
H. M. Cushing	C. R. Reid
J. H. Foote	A. E. Silver
R. L. Frisby	Philip Sporn
W. D. Hardaway	Robert Treat
N. B. Hinson	Sidney Withington
J. W. Lingary	Edwin D. Wood

Transportation

W. S. H. Hamilton, Chm., New York Central System, 466 Lexington Avenue, New York, N. Y.	
R. Beeuwkes	Fraser Jeffrey
G. E. Bishop	L. C. Josephs
John C. Davidson	R. L. Kimball
C. M. Davis	A. J. Klatte
E. G. Davis	F. C. Lindvall
J. V. B. Duer	P. A. McGee
D. D. Ewing	R. J. Needham
E. B. Fitzgerald	J. A. Noertker
J. E. Gardner	F. B. Powers
Selby Haar	W. I. Slichter
P. H. Hatch	Dwight L. Smith
G. L. Hoard	W. M. Vandersluijs
	L. J. Turley

Future AIEE Meetings

Southern District Meeting

Miami, Fla., November 28-30, 1938

Winter Convention

New York, N. Y., January 23-27, 1939

South West District Meeting

Houston, Texas, Spring, 1939

North Eastern District Meeting

Springfield, Mass., May 1939

Summer and Pacific Coast Convention (combined)

San Francisco, Calif., June 26-30, 1939

Middle Eastern District Meeting

Scranton, Pa., October 11-13, 1939

Great Lakes District Meeting

Minneapolis, Minn., Fall, 1939

Delegates to IEC Meeting



THREE of the delegates who attended the ninth plenary meeting of the International Electrotechnical Commission held recently at Torquay, England (*EE Oct. '38, p. 424*); left to right: P. L. Alger (A'17, F'30) United States delegate, General Electric Company, Schenectady, N. Y.; K. E. G. Eriksson (A'13) Swedish delegate, Allmänna Svenska Elektriska Aktiebolaget, Ludvika; C. H. Sharp (A'02, F'12) president, United States National Committee, IEC.

Plans Already Initiated for 1939 Summer Convention

Plans for the AIEE 1939 combined summer and Pacific Coast convention to be held in San Francisco, Calif., June 23-29, are progressing actively under the leadership of S. J. Lisberger, general convention chairman, according to J. S. Moulton, publicity subcommittee chairman. The convention committee and its several subcommittees are hard at work on their plans and give assurance of an outstanding convention.

Every endeavor is being made to present a well-rounded program of technical papers which will appeal to all groups within the industry. The dual magnets of the Golden Gate International Exposition and the

scenic attractions of the Pacific Coast are being counted upon as additional attractions to produce a large attendance.

The personnel of the convention committee is as follows: S. J. Lisberger, *chairman*; D. I. Cone, *vice-chairman*; G. C. Tenney, *secretary*; R. O. Brosemer, *treasurer*. Subcommittee chairman: M. S. Barnes, *registration*; R. J. Cobban, *sports*; A. W. Copley, *reception*; E. A. Crellin, *hotel*; F. R. George, *trips and local transportation*; J. S. Moulton, *publicity*; Stanley Rapp, *transportation*; H. H. Skilling, *student activities*; W. C. Smith, *program*.

Transactions "Supplement" to Be Issued in December

As announced in the October issue and in a special brochure mailed to all AIEE members, a special TRANSACTIONS "Supplement" will be published by the Institute in December. To eliminate a point of confusion that has arisen, this "Supplement" is not a supplement to the annual TRANSACTIONS volume, but is being published for the benefit of those who have not subscribed to the TRANSACTIONS. Under the present publication policy, some of the Institute's technical papers and discussions are not published in the TRANSACTIONS section of ELECTRICAL ENGINEERING, but appear only in the bound TRANSACTIONS volume; the "Supplement" is a reprint of these papers and discussions. Thus, a member who did not subscribe to the 1938 TRANSACTIONS still can obtain all the technical material published by the Institute during the year by "supplementing" the material he received month by month in the TRANSACTIONS section of ELECTRICAL ENGINEERING with a copy of the TRANSACTIONS "Supplement."

Normally under the present publication policy, the TRANSACTIONS Supplement would contain approximately 350 pages, and

Future Meetings of Other Societies

American Association for the Advancement of Science. Winter meeting, December 27-31, Richmond, Va.

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 13-16, New York, N. Y.

American Physical Society. 223d meeting, November 25-26, Chicago, Ill.

224th meeting, December, Los Angeles, Calif.

Annual meeting, December 26-28, Washington, D. C.

American Society of Civil Engineers. Annual meeting, January 18-20, New York, N. Y.

American Society of Heating and Ventilating Engineers. Annual meeting, January 23-26, Pittsburgh, Pa.

American Society of Mechanical Engineers. Annual meeting, December 5-9, New York, N. Y.

Spring meeting, February 23-25, New Orleans, La.

American Society of Refrigerating Engineers. Annual meeting, December 6-8, New York, N. Y.

National Research Council, Highway Research Board. Annual meeting, November 20-December 2, Washington, D. C.

Society of Automotive Engineers. National transportation engineering meeting, November 14-16, New York, N. Y.

Annual meeting, January 9-13, Detroit, Mich.

Society of Naval Architects. Annual meeting, December 1-2, 1938, New York, N. Y.

the price to members would be \$1.00 per copy postpaid. Because of the effects of this year's transition in publication procedure, however, the 1938 Supplement will contain only some 85 pages and will be available to members at 50c per copy postpaid. The Supplement will be paper bound similar to ELECTRICAL ENGINEERING.

Advance orders are required because the number of copies to be printed will be determined by the demand. As the Supplement will be reprinted from the TRANSACTIONS early in December, those wishing to receive copies should place their orders with Institute headquarters immediately.

A convenient order form may be found on page 16 of the advertising section of this issue.

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**WATCH FOR ANNOUNCEMENTS OF
MEETINGS — DISCUSSIONS — INSPECTION TRIPS**

TO STIMULATE interest in the work of the AIEE Branch at the California Institute of Technology, Pasadena, officers of the Branch distributed promotional blotters among electrical-engineering students at that institution, imprinted as shown above. The blotter was evolved by S. G. Schneider, secretary of the Branch.

17-Year AIEE Index May Be Issued Soon

As announced in the October issue and in a special brochure mailed to all AIEE members, the issuance of a cumulative index to AIEE technical papers published during the 17-year period, 1922-38, is under consideration. Such a volume would complete the series of indexes covering Institute papers from 1884 to date, but will be issued only if there is sufficient demand for it. Orders are coming in daily, and indications are

that enough will be received ultimately to enable the index to be published at an acceptable price. Since the number to be printed, and consequently the price, will be determined by the number of orders received, it is doubly important that orders be placed promptly.

Covering some 2,500 reports and technical papers by several hundred authors and technical committees, the proposed index would comprise a volume of 150 or more 8 $\frac{1}{2}$ - by 11-inch pages containing some 15,000 reference entries alphabetically arranged. The style and arrangement of the index would be similar to the annual multi-entry indexes that have been published dur-

ing recent years for TRANSACTIONS and ELECTRICAL ENGINEERING. As an added inducement, it is planned that a copy of the previous index volume, covering the years 1911-21, will be given free of charge to those ordering copies of the new index, until the present stock is exhausted.

The price of the proposed 17-year index to AIEE members will range from \$1.25 upward, depending upon the quantity to be produced, but will be kept to a minimum. Those interested are urged to place their orders with Institute headquarters immediately.

A convenient form may be found on page 16 of the advertising section of this issue.

office of the committee is in Room 218 of the Federal Trade Commission Building.

Since the establishment of the committee, its executive members have taken the initiative in leadership. Several private conferences, usually under the guidance of W. O. Douglas, chairman of the Securities Exchange Commission, were held. Among those who participated at these conferences were: Robert Jackson and Thurman Arnold, No. 1 and No. 2 trust-busters; Jerome Frank, author of "Law and the Modern Mind," and "Save America First"; Herman Oliphant, treasury official, author of the Undistributed Profit Tax; Isador Lubin, labor statistics; and Leon Henderson, former WPA economist.

An informal conference, at which ten leading business men attended, met with Richard Patterson of the Department of Commerce. Among them were: E. R. Stettinius, chairman of the board of the United States Steel Corporation; W. A. Harriman, chairman of the board of the Union Pacific Railroad; Clarence Francis, president of the General Foods Corporation; and S. Clay Williams of the Reynolds Tobacco Company.

Current Items From American Engineering Council

AEC Staff Analyzes the Government Inquiry Into Monopoly

An AEC staff analysis of the history and present status of the monopoly inquiry which may provide a basis for new Federal legislation on wages, prices, patents, and other fundamental economic industrial questions

THE prolonged depression with its "recessions" has accentuated the waxing problem facing the administration of how and by what means our economic mechanism may be made to function in such a way as to bring about real recovery in business conditions. This has brought to the fore the need of an inquiry into the possible causes preventing such recovery.

This resulted in the passage of the joint resolution (S.J.300) by Congress establishing a Temporary National Economic Committee to make such inquiry. The inquiry is to be an antimonopoly inquiry. There is the feeling that in due time this "temporary" committee will develop into a permanent committee or some such body.

The establishment of the National Economic Committee to make an antimonopoly investigation is no new thing in our economic and political history. Every business depression led to such investigation and was followed by legislation and the creation of a permanent body to deal with various aspects of the monopoly problem. With this established historical precedent the creation of the antimonopoly inquiry was an inevitable procedure, and the passage of legislation to further regular business is sure to follow. What the nature of the act will be is of course difficult to forecast.

COMPOSITION OF THE COMMITTEE

The committee is composed of 12 members as follows: (1) three members from the Senate appointed by the president; (2) three members from the House of Representatives; and (3) one representative from each of the following departments: Department of Justice, Department of the Treasury, Department of Labor, Department of

Commerce, Securities and Exchange Commission, and the Federal Trade Commission.

The three Senators appointed are: O'Mahoney, Borah, and King; the three representatives: Sumners, Eicher, and Reece; the six executive agency members; Thurman Arnold, assistant attorney general, Hon. O. Douglas, chairman of the Securities and Exchange Commission, Herman Oliphant of the Treasury Department, Garland Ferguson, chairman of the Federal Trade Commission, R. C. Patterson, assistant secretary, Department of Commerce, and Isador Lubin, chief of Bureau of Labor Statistics.

Thus, from the point of view of structure, the committee is legislative-executive in character, with a personnel that dominantly has a decided antimonopolistic bias. However, opinions vary as to how the committee as a whole will approach the problem. In some quarters impressions are current that the approach will be through the avenue of business baiting. In other quarters, the belief exists that the inquiry will be pursued in a spirit of complete objectivity, and that it will be nonpartisan and free from any admixture of politics. According to the *Washington Review*, "legislative members of the committee have given assurance of their intention to make a fair, impartial study, so as not to cause business apprehension."

At its first executive meeting, Senator J. C. O'Mahoney was selected permanent chairman, Representative Sumners, vice-chairman, and Leon Henderson, executive secretary. There also was appointed an executive committee consisting of Senator O'Mahoney, Representative Sumners, Thurman Arnold, Richard Patterson, and Isador Lubin, to function while the general committee is not in session. The executive

PLAN OF WORK

The present plan of work for the committee is to call upon the proper government agency for a specific study of certain aspects of a particular industry or business. Meanwhile, groundwork is being laid by each of the six agencies represented on the committee to make ready certain accumulated information on various business enterprises, which indicate monopolistic policies and practices. The extent to which such practices affect the proper working of the price structure of our economic mechanism, causing what economists call an unbalanced price structure, will be carefully analyzed.

The committee met on July 7 and outlined a general scheme of approach to the study designating the different departmental objectives. Since then, much preliminary work has been undertaken. The Department of Justice has investigated industrial combinations and their price policies and will make available pertinent data which it has accumulated in the investigation and prosecution of antitrust cases. The Federal Trade Commission has concentrated on problems of unfair trade practices in production and distribution, and existing combination in business and in industry. The Securities and Exchange Commission has investigated investments of insurance companies, corporate finance, and investment banking credit. The Department of Commerce is presenting an economic review based upon the size of various industrial organizations, a report based on studies from the NRA experience. It also would make available certain data from the Census Bureau, the Patent Office, and the research from the Trade Association and National Income Sections. The Labor Department has co-ordinated the data in the Bureau of Labor Statistics on wages, cost of living, and unemployment, with the data of the other agencies.

The Bureau of Labor Statistics representing the Department of Labor also is preparing charts that will show up these industries in which prices have been steady or fairly steady over a period of time. This

chart is superimposed on charts showing the nature of steadiness or irregularity in various industries and will show the relations between these three factors. These charts will indicate the points at which the economic system begin to endanger steady employment and income. The department then will turn to other agencies such as the Federal Trade Commission for a further and detailed study of the problem. The Treasury Department has concentrated on matters of taxes and will present data relevant to "tax escape devices," and also data on bids for government contracts which may indicate concerted efforts on the parts of manufacturers to maintain identical prices for their products.

SCOPE OF INVESTIGATION

Careful analysis of the issues involved in this "full and complete study" makes it clear that the investigation is to be more than merely antimonopoly. It is to be a broad and all inclusive study of any and all parts of our economic structure, the nature of their interrelationship, and the manner in which they function in American present-day economy. Thus the study will extend into a careful and detailed scrutiny of virtually every aspect of management and administration policies of every great enterprise in the country. It will cover everything touching the form, structure, and function of every large business organization. As one of the men of the committee remarked: "This is the most important investigation ever to be made of the economic life of the most important nation in the world."

To allay apprehension on the part of business and industry, members of the committee give assurance that politics will not enter as a factor in influencing the formation of their opinions and conclusions. Factual data alone, it is stated, will serve as a basis for recommendations to Congress and president as to the best and most feasible guide policy of control and regulation of business practices within the framework of our existing economy.

OUTCOME OF INVESTIGATION

There is a natural undercurrent of anxiety on the part of industrialists, as to what will be the outcome of this investigation. Prognostications are, at present, premature and hazardous. Examination of the basic theoretical principles, enunciated by some members of the committee in their writings, brings to light two possible recommendations for governmental policy. One is the break-up of monopoly and corporate concentration, so as to bring about the existence of a free competitive market; the other is the further increase of governmental control and "a shift in the manner of administered prices." These principles are also clearly enunciated by President Roosevelt in his April message to Congress, asking for the investigation. He says: "The power of a few to manage the economic life of the nation must be diffused among the many or be transferred to the public and its democratically responsible government. If prices are to be managed and administered, if the nation's business is to be allotted by plan and not by competition, that power should not be vested in any private group or cartel,

however benevolent its professions profess to be." The president is further on record in favor of amendments to the antitrust laws that would set down specific standards and then would place upon the corporation the responsibility of proving that it had not violated those standards, if evidence is produced to the contrary. In other words, a corporation would be expected to be prepared to prove that it had not engaged in practices tending to restrain competition.

THE "BERLE MEMORANDUM"

One of the contributions made to the committee investigating monopoly is contained in the so-called "Berle Memorandum" prepared by A. A. Berle, Jr., one of the economic advisers to the administration. Its criticisms of the undistributed profit tax, of the proposed federal incorporation and licensing laws, of the "imposed shotgun regulation of the New Deal" has gained extra circulation, if not weight, because the author has been an adviser of administrative policies for several years.

The significance of the Berle Memorandum is that it gives business men and financiers a hint of the nature and scope of the investigation that is to be made. It is an outline of a partial analysis of existing business organizations and of the business practices in the country, suggesting methods of controlling our business system so that it will work. The objectives of the investigation are set forth clearly in the introductory statement: "The investigation of business organization and practices should be essentially a search to find an organization of business that actually works."

Three tests of the success of business organization are recommended. These include the provision for: (1) more goods, better quality of goods, and lower prices of goods; (2) more jobs, better paying jobs, and steadier jobs; (3) the accomplishment of this process must be with due regard for the liberty and self-development of the individual. Any plan for control should have these criteria as its main objective, else it means very little.

For purpose of better clearness and understanding, we believe it is best perhaps to quote a statement of the summary verbatim.

"First, the general scope of the investigation ought to be a search for an organization of business that actually works;

"Second, the standard must be whether it supplies the existing and developing wants of the people as they appear;

"Third, that this involves the provision of an adequate supply of goods;

"Fourth, and a distribution system that takes these goods toward known wants to the maximum degree possible;

"Fifth, that the system must provide a maximum number of people with means of satisfying those wants through a contribution to the system;

"Sixth, that the system must provide the people engaged in the process with a manner of life, which at least tends to satisfy a fair proportion of their wants;

"Seventh, the system must evolve a method of organization that does not interfere unduly actually or potentially, with the liberty of the individual; i.e., that its controls must release more individuality than they suppress;

"Eighth, that there is no need to assume that these tests will be met by any single system or any single standard of size or set of practices at any given point."

Copies of the memorandum are available from AEC headquarters, 744 Jackson Place, Washington, D. C.

Seventh International Management Congress

Sponsored by some 20 national technical, economic, statistical, and business organizations, of which American Engineering Council was one, the Seventh International Management Congress held in Washington, D. C., September 19-24, brought together a remarkable group of leaders of industry and management, not only from the United States and Canada but from 20 additional nations. The paid registration was approximately 1,500.

William L. Batt, president of SKF Industries, past-president of the American Society of Mechanical Engineers and member of the AEC executive committee, was elected president of the International Committee of Scientific Management, and Sweden was chosen as the place of meeting for the Eighth International Management Congress to be held in 1941. Mr. Batt succeeded Viscount Leverhulme of London as president. The congress was opened with a message from the Honorable Cordell Hull, Secretary of State, delivered by Undersecretary Messersmith, because of the pressure of world events.

MANAGEMENT'S NEW RESPONSIBILITIES

The program of the congress was divided into two sections with over 200 papers presented in abstract by special rapporteurs, at six parallel technical sessions. This division of the program had in general the theme of improvement of techniques of management in administration, personnel, production, distribution, agriculture, and the home. The second part of the program had as its theme the responsibilities of management as the functioning group in industry and trade which has the task of writing the objectives of labor and capital for the common good of both these factors and the public.

Management's responsibilities were clearly shown to have entered the professional field due to the advanced scientific methods of production. It was pointed out that to provide social security, there must be a reorientation of business to the great economic and social forces which now surround and control their own activities. That management must be conducted along the lines that would develop mutuality of interest of the executive and the workers. This new concept must be foremost among the aims of enlightened industrial management.

Closely akin to the responsibilities emphasized in the management and industry relationship were those of management and labor, the problems of which must be settled outside of party politics. The technological progress within recent years also has created new problems which management must face and solve wisely.

Desirable social developments can be realized only through the action of two forces: better technical developments, and better management. The greatest management problem is that of determining the most advantageous balance between the two prin-

ciples of decent group life and properly oriented operation. Management no longer represents a single interest, but rather it functions on the basis of a trusteeship, endeavoring to maintain a proper balance of equity between the shareholder, the jobholder, the customer, and the public in general.

A NOTE OF HISTORY

L. P. Alford called attention to the fact that the organization of the Seventh International Management Congress was one of the indirect products of the inquiry into waste in industry, undertaken by AEC in 1920-21. At that time, the newly organized Czechoslovakian Government was searching for ideas for the development of industry and the published report of Council on "Waste in Industry" came to the attention of Doctor Stepanek, the Czechoslovakian minister to the United States. He, with Doctor Spacek, the technical attaché of the legation, called on Council and asked whether a way might be found to call a conference in Czechoslovakia that would enable the government to take advantage of the recommendations of the report on "Waste in Industry" in his own country. As a result of this inquiry, representatives of AEC and its member organizations developed a special committee which, in co-operation with the Czechoslovakian Government and the Department of State of the United States, arranged for the organization of the First International Management Congress held in Prague in 1924.

So much interest was aroused at this congress, that a number of the nations repre-

sented proposed that other nations organize committees of scientific management and that a second congress be held having as its basis international co-operation in widening the understanding of scientific management principles. In consequence, the second congress was held in Brussels in 1925 and there followed in order, congresses in Rome 1927, Paris 1929, Amsterdam 1932, London 1935, and the Seventh Congress just closed, held in Washington in 1938.

PARTICIPATION OF AEC

It was natural, therefore, that representatives of AEC should take an active part in the organization and in the deliberations of the Seventh International Congress. Many members of the official family of Council participated in presenting papers and discussions.

The executive secretary of AEC, at the request of the co-ordinating committee headed by W. L. Batt, acted as liaison secretary for the congress in all Washington matters including general arrangements for the meetings, relationships with State, War and Navy, Commerce, and other government departments, the social events and the program for the general sessions. Some 20 members of the staff of the United States Bureau of Foreign and Domestic Commerce were assigned to him by the secretary of Commerce and the director to assist in managing the meetings, and the staff of the Chamber of Commerce of the United States co-operated in perfecting the physical arrangements for the meeting under the direction of the president and the secretary of the chamber.

See the discussion in AIEE TRANSACTIONS, 1914, page 996, the article by L. Fleischmann in the *General Electric Review*, April 1924, page 260, and the article "Abnormal Behavior of Iron-Cored Reactors in Condensive Circuits" by H. B. Dwight, *Electric Journal*, 1924, volume 21, page 324.

Recently the phenomenon was described as a case of trouble in testing, by B. L. Goodlet, *Journal of the Institution of Electrical Engineers (England)*, 1937, volume 80, page 490, and in a discussion on page 329 of volume 82, 1938, E. V. Clark of Australia described its use as a college laboratory experiment.

Very truly yours,
H. B. DWIGHT (A'11, F'26)

(Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge)

Tensors—in Words of One Syllable

To the Editor:

Albert Einstein in his new book ("The Evolution of Physics," by Albert Einstein and L. Infeld, New York, 1938, Simon and Schuster, page 226) says, "Modern physics is simpler than the old physics and seems, therefore, more difficult and intricate." That is, while the reasoning becomes simpler the necessary groundwork becomes more extensive. So it is with the tensor, for its power lies in the simplification it affords. Like every progressive innovation in symbolic mathematics, it involves a condensation of reasoning. But the obscurity of the symbolism tends to increase in proportion to the gain in compactness. The brevity of the tensor, its best quality, is the greatest source of difficulty for the student. We are dealing here with one of those abstract physico-mathematical concepts which are usually well understood only after long acquaintanceship and patient application. A great many of us are trying vainly to cover too much ground in a single step.

Professor Skilling's straightforward article is therefore most timely and welcome. His scope is small enough to allow him to discuss in simple language just what a tensor is, without too much abstraction. But to gain a good understanding of the subject by the reading of any single article seems to be asking too much. One should read the references listed, as they are all good ones. By reading them all, one should gain a basic familiarity with the field. I would like to add Kron's articles in the *General Electric Review*.

Among textbooks, it would be hard to find any as elegant, masterful, and straightforward as Gibbs-Wilson. Wills, it is true, being more recent, is more up-to-date and takes advantage of the newer notation, but it is not as good a book for study without tutoring. Sheppard should not be missed by anyone seriously interested in tensors. Going beyond the books listed, the student will find much excellent material in some of the works on relativity.

Skilling's emphasis on the fact that the tensor is a shorthand representation of a whole group of related but distinct physical entities is important, for it is fundamental that the ensemble is treated mathematically as a single individual. The illustration of

Letters to the Editor

CONTRIBUTIONS to these columns are invited from Institute members and subscribers. They should be concise and may deal with technical papers, articles published in previous issues, or other subjects of some general interest and professional importance. ELECTRICAL ENGINEERING will endeavor to publish as many letters as possible, but of necessity reserves the right to publish them in whole or in part, or reject them entirely.

ALL letters submitted for consideration should be the original typewritten copy, double spaced. Any illustrations submitted should be in duplicate, one copy to be an inked drawing but without lettering, and other to be lettered. Captions should be furnished for all illustrations.

STATEMENTS in these letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the American Institute of Electrical Engineers

Critical Conditions in Ferroresonance

To the Editor:

The list of references given at the end of the paper by P. H. Odessey and E. Weber on resonance with iron-cored inductances [*EE, Trans. Sect., Aug. '38*, p. 444] contains no articles in the English language earlier than 1931. However, this phenomenon was in-

dependently observed, and described by the writer and C. W. Baker in 1911 in the article "Double Voltages in Circuits having Capacity and Inductance," in *The Electric Journal*, 1911, volume 8, page 1102. At that time, as in several later instances, the phenomenon was dangerous and harmful to apparatus on which it occurred. When a small transformer was connected between ground and the terminals of generators, for testing purposes, an unexpectedly high voltage appeared in an erratic manner, which punctured the generator insulation. Sometimes a high voltage and sometimes a low one was obtained, depending on the part of the cycle at which the switch was closed.

When the phenomenon was reproduced in a laboratory at that time, curves similar to those of figure 2 of the paper by Odessey and Weber were obtained by measurement and also by calculation, using the saturation curve of the transformer magnetizing current. An oscillograph was used to show that the current contained prominent harmonics, particularly when the larger of the two voltages was obtained.

A few years later, the writer observed this phenomenon in connection with a high-voltage insulator test, where again it gave trouble, as it did in some other cases noticed.

the d-c network in terms of the vector notation is a clever adaptation of the method to the simplest possible case, familiar to all. It seems a more useful example than the one about the springs, though to a person with a good theoretical knowledge of elasticity, the latter would be better. Substitution of words in place of symbols makes the discussion of the vector idea much clearer than it would have been otherwise.

The use of sample numerical problems in these articles cannot be commended too highly. Many scientific men find it difficult to express their results in terms of homely, numerical examples. Unfortunately, few readers not trained expressly in the formal logic of mathematical demonstration are able to handle *pure* scientific articles. We need more authors who will summarize their papers by means of elementary numerical examples. Let's have more articles like the present one.

Very truly yours,
ELLIS BLADE (A'35)

(Technical Consultant, John Chatillon and Sons,
New York, N. Y.)

D-C Transformers and Transmission

To the Editor:

T. C. Lennox and E. V. De Blieux in a very interesting paper "A D-C Transformer," published in the TRANSACTIONS section of the September 1938 issue of ELECTRICAL ENGINEERING on pages 554 to 558, describe a device using a mechanical commutator in conjunction with stationary transformers to transform direct current from one voltage to another.

In the discussion of this paper and C. C. Herskind's paper "New Types of D-C Transformers" which was published in the November 1937 issue (in which d-c trans-

formers of the mercury-tube type are described, J. J. Linebaugh suggests that "perhaps the d-c transformer of the future will be a combination of the two lines of attack covered by these papers."

It might be of interest to some of the readers to know that a "combination of the two lines of attack" has been studied and successfully tried by the writer and Doctor Klaus Froehmer at the research laboratories of the AEG, Berlin, Germany, in 1932.

Although the prime object of this study was not so much the development of a d-c transformer but rather the transmission of power from one a-c system to another by means of direct current of high voltage, it is obvious that the principles involved are applicable to the d-c transformer as well as the d-c transmission circuit since the two problems differ only inasmuch as the sequence of rectification and inversion is reversed.

In our experiments we tried to overcome the difficulties which result from the unsatisfactory breakdown voltage of gas or vapor-filled vacuum tubes when applied to high-voltage transmission circuits.

As shown in the wiring diagram, figure 1, both at the rectifier and the inverter end of a d-c transmission system a rotating commutator was used whose purpose it was to connect the mercury vapor tubes to the windings of the rectifier and inverter transformer, respectively, only at such times when they were supposed to carry the current. After the current ceases to flow over an anode it is immediately disconnected by the separation of the rotating segment and the stationary brush of the commutator. The connection is re-established shortly before the current commences to be carried by the anode again. It is obvious that in this way the commutator is relieved of the duty of interrupting the current since the anode current is extinguished before the contact is broken by the process of commutation in the tube circuit. The vacuum tubes in turn are relieved from the stress of the high inverse voltage during the periods of nonconduction, since the high inverse voltage will now appear across the insulating gap between the brush and the segment of the commutator.

With a suitable design of the commutator it is thus possible to take care of voltages which considerably exceed the breakdown voltages of gas- or vapor-filled vacuum tubes. As the commutator does not function in this combination as a current interrupter it is more appropriate to describe it as a "synchronous disconnector switch."

With the experimental disconnector switch shown in the photograph, figure 2,

and six mercury-vapor tubes in three-phase full-wave connection, 300 kw was rectified and a d-c voltage of 75,000 was obtained without any arcing or flashover.

The disks were made of compressed layers of paper with a resinous compound in which segments of brass were laid in. The brushes consisted of resilient German silver; they were mounted on a ring which could be angularly shifted in operation by means of a remote control arrangement. A four-kw synchronous motor was used to drive the rotating disks at a speed of 1,500 rpm.

It is to be hoped that the combination of tube circuits and mechanical commutators will be given further study since it offers interesting possibilities. Each partner to this combination namely, eliminates the inherent weakness of the other one, that is, the insufficient breakdown voltage of vacuum tubes and the arcing of rotating commutators.

Very truly yours,
HANS LAUB (M'36)

(Chief Engineer and Assistant to the President,
Hanovia Chemical and Manufacturing Company,
Newark, N. J.)

Some Electronic Switching Circuits

To the Editor:

Referring to the letter to the editor by H. A. Brown and P. W. Ryburn, published on page 36 of the August 1938 issue of ELECTRICAL ENGINEERING and to the last paragraph of my article "Some Electronic Switching Circuits" on page 211 in the May 1938 issue, I would like to point out that this paragraph states that the minimum R_1C_s product rather than the minimum impulse interval would be 0.25 microsecond. There is considerable difference in meaning because the time constant, as Brown and Ryburn are aware, gives the time only for the interval during which the voltage across the condenser C_s has dropped to about 37 per cent of its peak value. The impulsing interval, while dependent on the time constant, will be much greater since the voltage must drop approximately exponentially below the deionizing potential of the type-885 tube before the 885 will stop conducting and the cycle can be repeated.

The range of values given for the R_1C_s product was taken directly from sweep-circuit data, where C_s is the value of the external capacitor. The circuit capacitances, while negligible for large values of C_s , would not be negligible, of course, with small values of C_s .

In the investigation reported in this paper, the operation of the switching circuits was the primary interest. An exhaustive study of impulsing circuits was not needed since these could easily be made to have time constants appreciably lower than those of the switching circuits.

For the circuit shown by Brown and Ryburn I believe that an impulse interval of one microsecond is a noteworthy accomplishment.

Very truly yours,
C. C. SHUMARD (M'37)

(Radio Engineer, RCA Radiotron Division, RCA
Manufacturing Company, Inc., Harrison, N. J.)

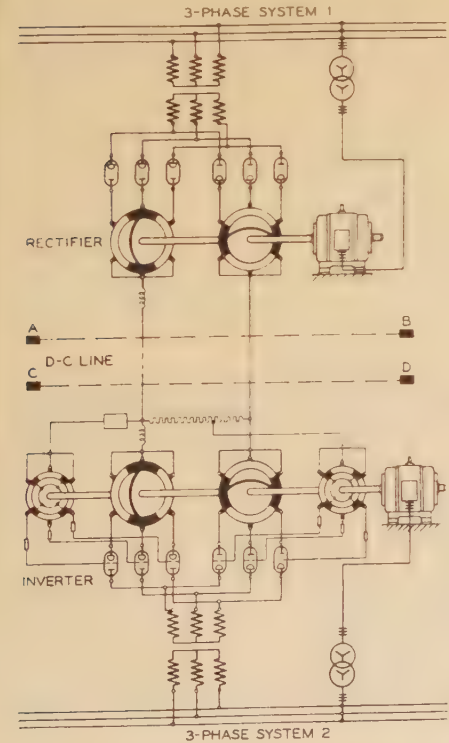


Figure 1

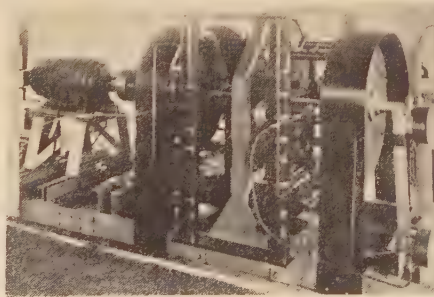


Figure 2

Personal Items

E. C. Crittenden (A'19, M'22) has been appointed chairman of the Institute's committee on research. Mr. Crittenden was born in 1880 at Oswayo, Pa., and received the degree of bachelor of arts at Cornell University in 1905. Following his graduation in 1905 he continued graduate studies at Cornell and was appointed instructor in physics, a position he held until he became assistant physicist in the National Bureau of Standards, Washington, D. C., in 1909. Subsequently he was appointed associate physicist, and physicist. During 1915-17 he was chief of the illuminating-engineering section and during the periods 1917-18 and 1920-21 he was chief of the photometry and illuminating engineering section. Since 1921 Mr. Crittenden has been chief of the electrical division of the National Bureau of Standards, and in 1933 was designated also as assistant director for research and testing. Mr. Crittenden has represented the United States at recent meetings of the International Committee on Weights and Measures; was president of the United States National Committee of the International Commission on Illumination from 1929 until 1935, and was a delegate to the sessions of that commission held in 1924, 1928, and 1931. He was president of the Illuminating Engineering Society during 1935, and of the Optical Society of America during 1932-33.

J. D. Wood (A'19, M'27) has been elected president of the Roller-Smith Company, New York, N. Y. Mr. Wood was born November 30, 1894, at Wichita, Kansas, and received the degree of bachelor of science from both Guilford College (1915) and Haverford College (1916); in 1917 he received the degree of master of arts from Haverford. In 1918 he was employed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and after completing the graduate student course of that company he was transferred to the supply engineering department. Later he became engaged in the development of protective devices and remained with the Westinghouse Company until 1923. In that year he resigned to become engaged in the design of oil circuit breakers for the General Electric Company, Schenectady, N. Y. Later

in the same year he became division engineer for the Condit Electrical Manufacturing Corporation, Boston, Mass., and remained there until 1929, when he joined the engineering staff of the Roller-Smith Company at Bethlehem, Pa. At the time of his election to the presidency of the company he was chief engineer.

E. C. M. Stahl (M'27) has been appointed chairman of the Institute's committee on power generation for the year 1938-39. Mr. Stahl was born at St. Paul, Minn., in 1891 and was graduated from Cornell University with the degree of mechanical engineer in 1913. Following his graduation he became a special apprentice for the New York Central Railroad, and in 1914 became a draftsman. During the World War Mr. Stahl held a commission as captain in the Coast Artillery Corps of the United States Army, returning to the New York Central Railroad in 1919 as an inspector in the electrical department. Following a brief association with the Pittsburgh Transformer Company he was appointed electrical field engineer for the Brooklyn Edison Company, Inc., in 1922, and in 1926 was appointed assistant superintendent of the Hudson Avenue station of that company. In 1928 Mr. Stahl was appointed engineer of tests and two years later became assistant operating superintendent. In 1934 he was made operating superintendent of the Brooklyn Edison Company, and in 1937 was transferred to the Consolidated Edison Company of New York, Inc., as assistant manager of production.

M. J. McHenry (A'11, M'20, vice-president) has been appointed director of sales promotion of the Hydro Electric Power Commission of Ontario. Mr. McHenry was born at Catasauqua, Pa., in 1888, and received the degree of bachelor of science in electrical engineering at McGill University in 1910. Following his graduation he was employed by Smith, Kerry, and Chase, a Toronto firm of consulting engineers, until 1912. In that year he was employed by the Canadian General Electric Company as sales engineer in Toronto, and in 1916 he became assistant manager of apparatus sales in the Toronto

district. In 1918 Mr. McHenry became manager and secretary-treasurer of the Walkerville Hydro-Electric System and remained as chief executive of that system until 1924. In that year he became sales manager of the Ferranti Electric Company, Ltd., which position he relinquished in 1926 to become manager of the United States sales department of the Canadian General Electric Company. In 1930 he was appointed district manager for Ontario, a position he held until his recent appointment to the Hydro-Electric Power Commission.

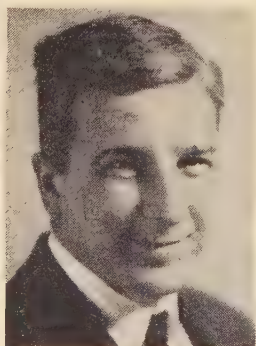
C. M. Laffoon (A'24) has been appointed chairman of the Institute's committee on electrical machinery for the year 1938-39. At present manager of the a-c generator engineering department of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., Mr. Laffoon was born at Coldwater, Kans., in 1888, and was graduated in electrical engineering from the University of Missouri in 1914. He then received an appointment as research assistant at the University of Missouri, enrolled as a graduate student, and received the degree of master of arts in 1915. Following a year of construction engineering for a firm of consulting engineers in Kansas City, Mo., he became affiliated with the Westinghouse Company in 1916. He has presented several papers on electrical machinery before the Institute, and has been an extension lecturer in the graduate school of the University of Pittsburgh for the last several years.

H. C. Wolf (A'16, M'23) has been elected president of the Atlanta Gas Light Company, Atlanta, Ga. Mr. Wolf is a native (1891) of Edwardsville, Ill., and a graduate of the University of Illinois with the degrees of bachelor of science, master of science, and electrical engineer. After holding a preliminary position he became assistant engineer for the Illinois Public Utilities Commission, remaining in that capacity for two years before becoming superintendent of the Edwardsville (Ill.) Water Company in 1916. During the World War Mr. Wolf served in the United States Army Corps of Engineers, following which he became industrial engineer for two consulting-engineering companies in 1929. Two years later he received an appointment as assistant chief engineer of the Public Service Commission of Maryland, and in 1922 became chief engineer.

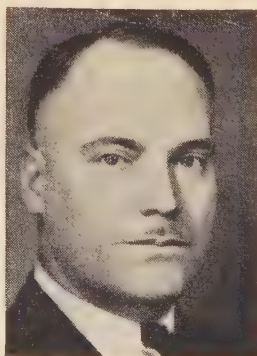
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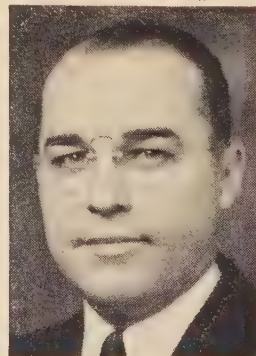
E. C. M. STAHL



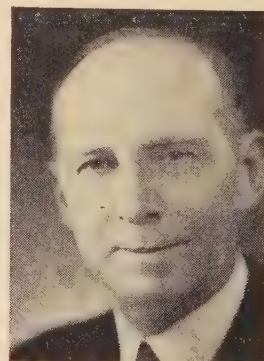
J. D. WOOD



C. M. LAFFOON



H. C. WOLF



E. C. CRITTENDEN

Gas Age Record



R. M. HENDERSON



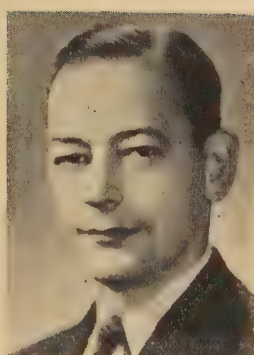
H. W. CODDING



M. F. SKINKER



H. R. CRUMLEY



D. L. BEMENT

Electrical World

In 1929 Mr. Wolf resigned to become assistant to the vice-president of the Central Public Service Corporation. In 1933 he became vice-president of the Consolidated Electric and Gas Company, and in 1934 moved to Muncie, Ind., to assume the duties of president of the Central Indiana Gas Company and associated companies in Indiana under common ownership and under the management of the Stone and Webster Service Corporation. The Atlanta Gas Light Company also is a Stone and Webster property.

R. M. Henderson (A'07, M'13) has been elected vice-president of United Engineers and Constructors, Inc., with offices at Chicago, Ill. Mr. Henderson was born at Willoughby, Ohio, February 2, 1879, and received the degrees of bachelor of science in electrical engineering (1902) and electrical engineer (1906) at Armour Institute of Technology. Following a period as electrical engineer for the Mexican Central Railway during 1902-04, he returned to the United States to become an engineer for the Arnold Company, Chicago. In 1907 he became affiliated with Stone and Webster, Inc., Boston, Mass., holding successively the positions of construction engineer, assistant construction manager, and district manager in the Chicago offices. From 1918 until 1928 Mr. Henderson was a vice-president of Dwight P. Robinson and Company, Inc., New York, N. Y. When that company was merged with three other firms to form the United Engineers and Constructors, Inc., in 1928, Mr. Henderson was appointed president of the Canadian subsidiary corporation of the new organization. Since 1932 he has been midwest manager of the company.

Eugene Holcomb (A'03) has retired from active service with the Consumers Power Company, Jackson, Mich., after 15 years as a member of the general office executive staff. A native (1868) of Cedar Springs, Mich., Mr. Holcomb first became identified with the electrical industry as an engineer in the California district of the Thomson-Houston Electric Company in 1887. Three years later he became assistant district engineer for the Edison General Electric Company, Portland, Ore., and in 1892 was made assistant manager of the Portland offices of the General Electric Company. Later he and some associates leased and operated the Capital Electric Company

properties in Springfield, Ill. Subsequently he was associated with the export department of the Westinghouse Electric and Manufacturing Company in New York, N. Y., and in Buenos Aires, Argentina; with the foreign sales department of the Allis-Chalmers Manufacturing Company at Milwaukee, Wis., and with H. M. Bylesby and Company at St. Paul, Minn. Mr. Holcomb returned to Michigan in 1913 to become president of the Continental Utilities Company at Lansing, continuing in that position for several years. He served also as general manager of the Central Michigan Light and Power Company, with headquarters at Alma. That property was acquired by the Consumers Power Company in 1924, and Mr. Holcomb was assigned to the executive staff at Jackson.

H. W. Coddington (A'19, M'25) has been appointed chairman of the Institute's committee on automatic stations. Mr. Coddington was born at Providence, R. I., in 1889 and was graduated from Massachusetts Institute of Technology with the degree of bachelor of science in electrical engineering in 1912. Following his graduation he received an appointment as cadet engineer for the Public Service Railway Company, Newark, N. J., and three years later was assigned to the distribution department of that company. In 1917 Mr. Coddington became assistant to the chief electrical engineer of The New York Edison Company, New York, N. Y., but returned two years later to the Public Service Railway Company as engineer in the distribution department. In 1920 he became distribution engineer in charge of the engineering work of the distribution department and was appointed assistant engineer in the electrical engineering department of the Public Service Production Company in 1924. Later he received a similar appointment in the Public Service Electric and Gas Company, Newark. For a time Mr. Coddington was associated with United Engineers and Constructors, Inc., in Newark.

M. F. Skinker (A'22, F'34) has been appointed chairman of the Institute's committee on electrochemistry and electrometallurgy. Doctor Skinker was born at Denver, Colo., in 1898 and received the degrees of bachelor of science in electrical engineering (1919) and master of science (1921) at the University of Colorado. Following his graduation in the latter year

he received a Rhodes scholarship at Oxford University, where he pursued research on the conduction of electricity in gases, receiving the degree of doctor of philosophy there in 1924. He then returned to the United States and became assistant research engineer in the electrical engineering department of the Brooklyn Edison Company, Inc., Brooklyn, N. Y. In 1926 Doctor Skinker was appointed assistant director of research of that company, and in 1937 he became director of research.

H. R. Crumley (A'26, M'37) has been appointed general superintendent of the Virginia Public Service Company, with offices at Charlottesville. Mr. Crumley was born in Atlanta, Ga., in 1900 and was graduated from the Georgia School of Technology with the degree of bachelor of science in electrical engineering in 1920. Following his graduation he was employed on the test course of the General Electric Company at Schenectady, N. Y., but remained there only one year before becoming affiliated with the Georgia Railway and Power Company. In 1926 Mr. Crumley became relay engineer for the New Jersey Power and Light Company; one year later he was appointed assistant superintendent of operation, and in 1932 became chief system operator. He joined the E. M. Gilbert Engineering Corporation, Reading, Pa., as electrical engineer in 1937, and later became consulting engineer for The Utility Management Corporation, Reading.

D. L. Bement (A'25) has been elected vice-president of the Northern Indiana Public Service Company, Hammond. Mr. Bement is a native (1900) of Goshen, Ind., and an electrical engineering graduate of Purdue University of the class of 1922. Following his graduation he became a cadet engineer for the Northern Indiana Public Service Company and has remained in the employ of that organization continuously. In 1924 Mr. Bement was appointed assistant superintendent of electric distribution and later became general electric superintendent of the system.

W. T. Teague (A'19) retired recently as director and vice-president of the Western Electric Company, New York, N. Y., after a service of 37 years with the Bell telephone system. Born at Napa, Calif., Mr. Teague began his career in communications in the

San Francisco office of the telephone company. Eight years later he was made district superintendent of the Sacramento offices of the Bell Telephone Company; later, after having served several years in Portland, Ore., as division superintendent of plant, he returned to San Francisco to be placed in charge of the engineering and construction of an important line. In 1920 he became plant superintendent at Cleveland, Ohio, and three years later was transferred to New York to assist in the organization and administration of the new installation department of the Western Electric Company. Later he became manager of that department, and in 1927 was elected vice-president and a director.

R. L. Webb (A'29, M'35) has been appointed chairman of the Institute's committee on membership. Born at Phelsenthal, Ark., in 1904, Mr. Webb received the degree of bachelor of science in electrical engineering at Rice Institute in 1926, before being employed on the test course of the General Electric Company at Schenectady, N. Y., and Pittsfield, Mass. In 1927 he was transferred to the relay design department of the General Electric Company at Schenectady and later at Philadelphia, Pa., where he remained until he was appointed assistant engineer for the Brooklyn Edison Company, Inc., Brooklyn, N. Y., in 1929. Mr. Webb was transferred to the electrical engineering department of the Consolidated Edison Company of New York, Inc., in 1937. He has been assistant chairman of the AIEE committee on membership since 1936, and has participated in committee work of the Association of Edison Illuminating Companies and the Edison Electric Institute.

H. H. Race (A'24, M'31) has been appointed chairman of the Institute's committee on Sections for the year 1938-39. A native (1899) of Buffalo, N. Y., he was graduated from Cornell University with the degrees of electrical engineer (1922) and doctor of philosophy (1927). Following his graduation in 1922, Doctor Race became a design engineer in the transmission and distribution department of the Philadelphia (Pa.) Electric Company, but in 1923 returned to Cornell as an instructor in advanced electrical theory. He continued in that position until he was appointed assistant professor in 1927. Since 1929 Doctor Race has been a research engineer in the research laboratories of the General Electric

Company, Schenectady, N. Y. In 1928 Doctor Race was awarded the AIEE National and North Eastern District prizes for initial paper. He is a member of the Institute's committees on planning and coordination, basic sciences, and research.

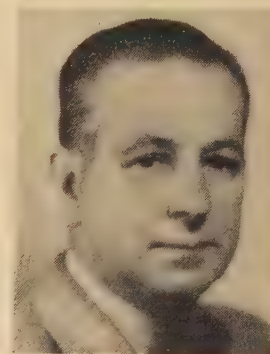
E. L. Splitstone (A'19, M'23) has been appointed chief engineer of the Emerson Electric Manufacturing Company, St. Louis, Mo. Mr. Splitstone was born at Kinsman, Ohio, in 1888 and was graduated from The Ohio State University in 1911. Following a brief affiliation with the Pennsylvania Railroad he worked for the Hydraulic Power Company, Niagara Falls, N. Y. In 1912 he became affiliated with the Emerson Electric Manufacturing Company as an assistant testing engineer. In 1913 Mr. Splitstone was made performance engineer; two years later he became commercial engineer; and he was chief production engineer from 1920 until his recent appointment as chief engineer. Mr. Splitstone has been active in committee work of the National Electrical Manufacturers Association.

W. S. H. Hamilton (A'19, M'26) has been appointed chairman of the AIEE committee on transportation for the year 1938-39. Mr. Hamilton was born at New Haven, Conn., in 1890, and attended Yale University before entering the testing department of the General Electric Company, Schenectady, N. Y., in 1911. Two years later he was transferred to the railway equipment engineering department, where he remained until 1918. During the World War Mr. Hamilton served as an engineer officer on a United States naval transport, following which he returned to the employ of the General Electric Company, remaining until 1931. In that year he was appointed assistant electrical engineer for the New York Central Railroad, and since 1934 he has been equipment electrical engineer.

H. P. Liversidge (A'12, M'17, past director) has been elected president of the Philadelphia Electric Company, Philadelphia, Pa. Mr. Liversidge was born at Norristown, Pa., September 29, 1878, and received his technical education at Drexel Institute, being granted the degree of bachelor of science in electrical engineering in 1898. Mr. Liversidge has been associated with the Philadelphia Electric Company continuously since 1898, having served successively

as assistant superintendent of operation, assistant superintendent of station design and construction, operating engineer, assistant chief engineer, chief engineer, and vice-president and general manager. Mr. Liversidge served as a director of the Institute from 1927 until 1931.

G. L. Crosby (A'15, M'26) has been elected vice-president of the Roller-Smith Company, New York, N. Y.; he will retain the duties of general sales manager. Mr. Crosby was born at Brookhaven, Miss., in 1883 and attended Millsaps College (Miss.) and George Washington University before becoming sales engineer and manager of the Cleveland (Ohio) offices of the Cutter Company in 1902. Two years later he entered the employ of the Stanley-G. I. Electric Manufacturing Company as a sales engi-



G. L. CROSBY

neer, but when that company was dissolved in 1905 he established his own sales-engineering offices at Cleveland under the firm name of Crosby, Craft, and Company. In 1910 Mr. Crosby became affiliated with the Roller-Smith Company as sales engineer and manager of the Pittsburgh (Pa.) offices. In 1912 he was transferred to the New York offices of the company and became successively general sales manager, assistant to the president, and vice-president in charge of sales.

C. B. Aiken (M'35) has established consulting engineering offices in the firm of McCutchen and Aiken at New York, N. Y. A native (1902) of New Orleans, La., Doctor Aiken was graduated from Tulane Univer-

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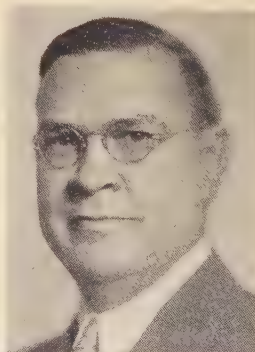


R. L. WEBB

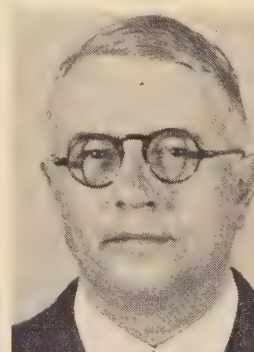
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H. P. LIVERSIDGE



E. L. SPLITSTONE



W. S. H. HAMILTON

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H. H. RACE

sity with the degree of bachelor of science in 1923. He then enrolled in the graduate school of Harvard University and received there the degrees of master of science (1924), master of arts (1925), and doctor of philosophy (1933). From 1926 until 1928 he was engaged in geophysical exploration with the firm of Mason, Schlichter, and Hay, Madison, Wis., and during the period 1928-35 was a member of the technical staff of Bell Telephone Laboratories, Inc., New York. Doctor Aiken was associate professor of electrical engineering in charge of communication at Purdue University, Lafayette, Ind., from 1935 until 1938.

J. D. Wright (A'36) has been appointed chairman of the AIEE committee on industrial power applications for the year 1938-39. Mr. Wright, who is assistant manager of the industrial department, General Electric Company, Schenectady, N. Y., is a native (1887) of Baraboo, Wis., and a



J. D. WRIGHT

graduate of the University of Wisconsin in the class of 1909. Following his graduation he became a student engineer in the testing department of the General Electric Company, and has remained in the employ of that organization continuously, having been successively an engineer in the industrial control engineering department, engineer in the steel mill section, engineer in charge of the steel mill section, assistant engineer in the industrial department, and manager of that department.

W. F. Hess (A'32) has been elected a vice-president of the American Welding Society. After having received the degrees of electrical engineer (1925) and doctor of engineering (1928) at Rensselaer Polytechnic Institute, Troy, N. Y., Doctor Hess served from 1928 until 1930 as an instructor in electrical engineering. In the latter year he was appointed assistant professor of electrical engineering and physics. In 1937 he was made assistant professor of metallurgy and was placed in charge of the welding laboratory, and one year later he received an appointment as associate professor of metallurgical engineering.

John Harisberger (A'02, M'10) has retired as general superintendent of the division of power supply of the Puget Sound Power and Light Company, Seattle, Wash., after a service of 40 years with that utility company

and its predecessors. Mr. Harisberger was born December 2, 1871 at Berne, Switzerland. He first became identified with the electrical industry when he was employed by the Northwest Thomson-Houston Electric Company and the Northwest General Electric Company, Portland, Ore., as a shop apprentice in 1892. As a young man he helped on the construction of the Snoqualmie Falls power plant, and upon its completion he became its first superintendent. Mr. Harisberger was a lecturer on generation and transmission of electric power at the University of Washington from 1905 until 1911, and was a member of the advisory board for the department of electrical engineering from 1916 until 1919.

K. L. Hansen (A'17, F'34) has been elected a vice-president of the American Welding Society. A native of Norway and a graduate of the University of Illinois, Mr. Hansen has held various positions with the Western Electric Company, Commonwealth Edison Company, Westinghouse Electric and Manufacturing Company, and the Louis Allis Company. Since 1932 Mr. Hansen has been consulting engineer for the Harnischfeger Corporation, Milwaukee, Wis. He is a member of the Institute's committee on electric welding and is a past chairman of the AIEE Milwaukee Section.

H. M. Sharp (M'34) vice-president in charge of plant operations for the Buffalo, Niagara, and Eastern Power Corporation, incorrectly was stated to have been elected general secretary of the Illuminating Engineering Society, on page 435 of the October issue. H. M. Sharp (nonmember) manager of the lighting bureau of the same company, has been elected to this office.

C. A. Adams (A'94, F'13, past president) has been elected a director-at-large of the American Welding Society. For many years Doctor Adams was professor of electrical engineering at Harvard University, and at present is professor emeritus at that institution. He was the founder and first president of the American Welding Society, and is an honorary member. He is a member of the AIEE committee on electric welding.

G. C. Sears (A'19, M'20) has become general superintendent of the division of power supply of the Puget Sound Power and Light Company, Seattle, Wash. Mr. Sears formerly was superintendent of power plants and transmission lines. A native (1884) of Salem, Ore., he has spent his entire technical career in the employ of the Puget Sound Power and Light Company during a period covering more than 36 years.

E. W. Conroy (M'32) who has been assistant to the general superintendent of light and power of the Puget Sound Power and Light Company, Seattle, Wash., has become superintendent of transmission. A native (1894) of Helena, Mont., and an electrical engineering graduate of the University of Washington, Mr. Conroy has been employed continuously by the company since 1922.

J. A. Cranston (A'08) recently was awarded an honorary life membership in the San Francisco (Calif.) Electrical Development League. He is a retired commercial vice-president of the General Electric Company. A biographical sketch of Mr. Cranston appeared on page 324 of the July 1938 issue of *ELECTRICAL ENGINEERING*, at the time of his retirement from active service.

F. T. Hague (A'14) incorrectly was associated with the General Electric Company in an item on page 436 of the October 1938 issue of *ELECTRICAL ENGINEERING*. Mr. Hague has been made manager of engineering of the steam division of the Westinghouse Electric and Manufacturing Company at the South Philadelphia (Pa.) works.

J. F. Calvert (A'27, M'35) has become professor of electrical engineering at Northwestern University, Evanston, Ill. Previously professor of electrical engineering at Iowa State College, Ames, he was once associated with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., for thirteen years, and was lecturer at the University of Pittsburgh during his affiliation with the Westinghouse Company.

W. J. Schuhmann (A'24) recently was elected treasurer of the Roller-Smith Company, New York, N. Y. Mr. Schuhmann is a native (1901) of New York, N. Y. He attended Pratt Institute and the Polytechnic Institute of Brooklyn (N. Y.), and has been associated with the Roller-Smith Company since 1916, first in the accounting department and later in the sales department.

R. M. Baker (A'35) now is employed in the research laboratories of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Until recently Mr. Baker was an instructor in electrical engineering at the Kansas State College of Agriculture and Applied Science, Manhattan.

P. G. Agnew (A'12, M'19) has been elected an honorary member of the American Home Economics Association in recognition of his part in organizing work on standards for consumer goods. Doctor Agnew is secretary of the American Standards Association, New York, N. Y.

K. V. Abakumoff (A'28) has been appointed assistant electrical engineer in the bureau of engineering, United States Department of Agriculture, Washington, D. C. Formerly Mr. Abakumoff was assistant electrical engineer for the Metropolitan Water District of Southern California, Los Angeles.

E. K. Rohr (A'37) now is employed in the electrical engineering department of North Dakota State College, Fargo. Previously Mr. Rohr was a mechanic in the electrical engineering department of Iowa State College, Ames.

E. L. White (A'26) now is employed on the Bonneville Project, Portland, Ore. Mr. White has been a communication engineer for the Puget Sound Power and Light Company, Seattle, Wash.

W. W. Glenny (A'38) has enrolled in the graduate school of Purdue University, Lafayette, Ind., and has been appointed to an assistantship in the department of engineering extension of the university. Mr. Glenny has been an electrical engineer for the Reliance Electric and Engineering Company, Cleveland, Ohio.

S. L. Guthorn (M'20) has been appointed superintendent of the New York group, National Park Service, United States Department of the Interior, New York, N. Y. Formerly Mr. Guthorn was superintendent of the National Park Service at Washington, D. C.

W. H. Mansfield (A'27) has been appointed Florida plant superintendent of the Southern Bell Telephone and Telegraph Company, Inc., with offices at Jacksonville. Formerly Mr. Mansfield was Mississippi plant superintendent of the company at Jackson.

H. H. Davenport (A'38) has become a member of the firm of the Audiphone Company of South Texas, San Antonio, Texas. Formerly Mr. Davenport was employed in the plant department of the Southwestern Bell Telephone Company, Corpus Christi, Texas.

R. C. Green (A'38) has become an instructor in electrical engineering at the Texas Agricultural and Mechanical College, College Station. Mr. Green has been a student engineer for the Dallas (Texas) Power and Light Company.

F. J. Zak (A'32) has become superintendent of distribution for the Fredericksburg district of the Virginia Electric and Power Company. Mr. Zak has been system engineer in the Richmond offices of the company.

M. B. Reed (A'36) has become a member of the electrical engineering department of Armour Institute of Technology, Chicago, Ill. Formerly he was assistant professor of electrical engineering at the University of Texas, Austin.

H. H. Bates (A'36) has been transferred to Detroit, Mich., as district plant engineer in the long lines department of the American Telephone and Telegraph Company. Mr. Bates has been employed in the Cleveland (Ohio) offices of the company.

R. C. Martin (A'34) has become assistant to the district manager of the Pacific Power and Light Company, Yakima, Wash. Mr. Martin has been employed in the technical control department of the Willamette Paper Company, Camas, Wash.

M. G. Marshall (A'37) now is affiliated with the James R. Kearney Corporation, St. Louis, Missouri. Formerly Mr. Marshall was an electrical engineer for the Commonwealth and Southern Corporation, Jackson, Mich.

R. M. Wainwright (A'37) has been appointed corrosion engineer for the Montana-Dakota Utilities Company, with field offices at Glendive, Mont. Mr. Wainwright formerly was assistant corrosion engineer for the Montana Power Company, Butte.

E. U. Thomas (A'36) recently became an engineer in the automotive division of the Gulf Research and Development Company, Pittsburgh, Pa. Previously Mr. Thomas was an engineer for the Union Switch and Signal Company, Swissvale, Pa.

F. S. Bacon, Jr. (A'37) recently was transferred from the general sales department of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., to the central station division of the company in Boston, Mass.

E. F. Schuster (A'37) has been employed as assistant electrical engineer with the Underwriter's Laboratories, Inc., New York, N. Y. Previously Mr. Schuster was a tester for the American Transformer Company, Newark, N. J.

R. A. Krasovec (A'31) has just completed an electrical project for the American Smelting and Refining Company at Bonanza, Nicaragua, and now is an electrical engineer for the United States Works Progress Administration at New York, N. Y.

E. J. Schiller, Jr. (A'38) has received an appointment as instructor in the department of machine design at Cornell University, Ithaca, N. Y. Mr. Schiller is studying for his master's degree in electrical engineering at Cornell.

W. S. Gordon, Jr. (A'27, M'35) has been appointed electrical engineer in the office of the constructing quartermaster, McChord Field, Fort Lewis, Wash. Formerly Mr. Gordon was supervising engineer for Vare Brothers, Philadelphia, Pa.

J. G. Barry (A'38) has become affiliated with the Bartol Research Foundation, Swarthmore, Pa. Formerly Mr. Barry was enrolled as a graduate student in the Moore School of Electrical Engineering at the University of Pennsylvania.

H. R. Stoddard (A'32) has been transferred to the Chicago (Ill.) district of the Simplex Wire and Cable Company. Mr. Stoddard previously was employed in the electrical engineering department of the company at Cambridge, Mass.

Norman Arnold (A'29, M'37) has become assistant professor of engineering drawing at Purdue University, Lafayette, Ind. Formerly he was assistant professor of general engineering drawing at the University of Illinois, Urbana.

G. W. Miller (A'35) has been transferred to the Zanesville, Ohio offices of the Line Material Company. Mr. Miller is an inspector for the company and previously was employed in the South Milwaukee, Wis., offices of the company.

Ray Blain (A'24, M'31) has been transferred to the office of the chief signal officer, United States Army Signal Corps, Washington, D. C. Previously Mr. Blain was a telephone plant engineer in the signal service at large, Omaha, Neb.

R. A. Galbraith (A'38) has joined the faculty of the electrical engineering department of the University of Missouri, Columbia. Formerly Mr. Galbraith was an engineer in the research department of The Detroit Edison Company, Detroit, Mich.

L. G. Brewer (A'37) has been appointed assistant superintendent of distribution for the Montana Power Company, with offices at Great Falls. Mr. Brewer formerly was distribution engineer in the Havre offices of the company.

W. McC. Runyon (A'20) has become a sales engineer in the Pittsburgh (Pa.) offices of the National Electric Products Corporation. Mr. Runyon has been a development sales engineer for that company, with offices at Ambridge, Pa.

J. I. Holbeck (A'24, M'36) has been appointed to the engineering staff of the Bonneville project at Portland, Ore. For the last 14 years Mr. Holbeck has been associated with the Minnesota Power and Light Company as relay engineer at Duluth.

I. J. Sattinger (A'36) now is employed as an electrical draftsman for the Loup River Public Power District, Columbus, Nebr. Formerly he held a similar position with the Commonwealth and Southern Corporation, Jackson, Mich.

Frank Worel (A'29) has been transferred to the Ypsilanti offices of the Michigan Bell Telephone Company as repair foreman. Formerly he was exchange repairman at Grand Rapids.

A. H. Pedersen (A'32) has been transferred to Toledo, Ohio, as assistant foreman for the Gulf Oil Corporation. Mr. Pedersen formerly held a similar position in the Philadelphia (Pa.) offices of that company.

Harold Gerard (A'36) has become an electrical designer for the firm of Holway and Neuffer, Tulsa, Okla. Mr. Gerard has been an electrical engineer for the Pierce Electric Company, Chicago, Ill.

L. R. Waugh (A'09, F'33) recently was appointed assistant project engineer for the United States Public Works Administration on the construction of the Grand River Dam and hydroelectric power plant in Oklahoma.

W. N. Clark (A'05, M'36) has been elected president of the Rocky Mountain Electrical League. Mr. Clark is president and manager of the Southern Colorado Power Company, Pueblo, Colo.

W. H. Bliss (A'30) has become an instructor of electrical engineering at the University of Maine, Orono. Mr. Bliss has been employed as a research engineer for RCA Communications, Inc., New York, N. Y.

V. A. Hanson (A'34) has resigned as vice-president and chief engineer of the Power Transmission Council, Boston, Mass., to become associated with the Whitney Chain and Manufacturing Company, Hartford, Conn.

O. A. Becklund (A'38) has been appointed instructor in the department of electrical engineering at the Case School of Applied Science, Cleveland, Ohio.

O. W. Muckenhirn (A'38) has become an instructor in the department of electrical engineering at the University of Minnesota, Minneapolis.

Peter Fries, Jr. (A'34) counselor at law, New York, N. Y., has been admitted to practice in the United States Patent Office as a patent attorney.

Harry Dunseath, Jr. (A'34) has become a draftsman for the consulting-engineering firm of Hunter and Hudson, San Francisco, Calif.

Obituary

Edwin Stafford Reid (A'96, M'12) died July 20, 1938. Mr. Reid was born May 21, 1865, at Brooklyn, N. Y. In 1884 he was employed by the New York Quotation Company, New York, N. Y., as inspector of instruments and after one year was placed in charge of the electrical department. In 1887 he became associated with a consulting engineer carrying on experiments and designing motors and traction operators for the elevated railway systems in New York. Mr. Reid became electrical engineer and superintendent of the Eastern Department of the Standard Underground Cable Company in 1889, and is said to have installed the first underground electric lighting system in the United States during his stay with that company, which lasted until 1896. In the latter year he became electrical and construction engineer for the National Conduit and Cable Company, becoming chief engineer of the British branch of the company in 1899. He later became European manager and electrical engineer for the company in both England and the United States. Mr. Reid served briefly as an engineer for the American Brass Company before retiring from active service in 1926 to devote a part of his time to consulting work in electrical engineering.

Walter J. Ducey (A'22, M'30) died September 29, 1938. Assistant electrical engineer on the staff of the Commonwealth and Southern Corporation, Jackson, Mich., Mr. Ducey was born June 23, 1894, at Grand Rapids, Mich., and was graduated from the University of Notre Dame with the degree of electrical engineer in 1917. He joined the engineering department of the Consumers Power Company in 1919, and six years later was made assistant electrical engineer for the Commonwealth Power Corporation of Michigan. He continued in that position

when the organization was managed successively by Stevens and Wood, Inc., and by Allied Engineers, Inc. When the latter company was dissolved in 1931, Mr. Ducey was appointed electrical engineer with the Consumers Power Company and was placed in charge of the engineering section. In 1936 the engineering department of the Consumers Power Company was merged with the Jackson engineering staff of the Commonwealth and Southern Corporation engineering clearing agent, and Mr. Ducey was appointed assistant electrical engineer. He was active in committee work of the former National Electric Light Association and of the Edison Electric Institute.

Frederick Webster Deck (M'30) senior engineer of the mechanical engineering division of the Philadelphia Electric Company, Philadelphia, Pa., died September 26, 1938. Mr. Deck was born March 28, 1896 at Washington, D. C., and received the degree of bachelor of arts at George Washington University in 1924. He then entered the University of Colorado and received the degrees of bachelor of science in civil engineering (1925) and civil engineer (1929). Following two preliminary positions, he served in the United States Army from 1917 until 1923, during which time he ultimately held a commission as captain in the Corps of Engineers. Mr. Deck entered the employ of the Philadelphia Electric Company in 1925 as a field engineer on steel tower work and later advanced to a position in full charge of all civil engineering work involving steel tower transmission line design.

James Townes Robertson (A'06, M'13) founder of the firm of J. T. Robertson and Associates, Birmingham, Ala., died September 6, 1938. Mr. Robertson was born at Abbeville, S. C., May 26, 1879, and was graduated from Clemson College with a degree in electrical and mechanical engineering in 1903. He was electrical inspector for the Southeastern Underwriters' Association, Atlanta, Ga., from the time of his graduation until 1911, when he became electrical engineer and inspector for the Mississippi Inspection and Advisory Rating Company at Vicksburg. Later Mr. Robertson was made secretary and electrical engineer, a position he held until 1925, when he became superintendent of the Abbeville Water and Electric Plant. In 1929 he became associated with the firm of A. H. Turner, Atlanta, as special agent and engineer; eight years later he established his own firm in Birmingham.

Charles Caesar Hawkins (A'03) retired electrical engineer of Kew, Surrey, England, died in August 1938. Mr. Hawkins was born March 15, 1864 at Lamberhurst, England, and was graduated from Magdalen College, Oxford, with the degree of master of arts. In 1889 he became associated with the firm of Johnson and Phillips, London, but one year later transferred his affiliation to the firm of H. Allen, Son, and Company, Ltd., Bedford. Mr. Hawkins remained with that firm until he established his own consulting electrical-engineering business in 1908 at Bedford. Later he continued his consulting practice in London until 1922,

when he became secretary of the department of technology of the City and Guilds of London Institute. Later he became superintendent of that institute before retiring from active service to devote a part of his time to private consulting practice.

Eugene Maxwell (A'96) expansion department, Western Public Service Company, Scottsbluff, Nebr., died July 23, 1938. From 1888 until 1894 Mr. Maxwell was engaged in building and operating electric light plants and distribution systems in the Northwestern part of the United States and Western Canada, and from 1894 until 1911 he held various positions for street railway systems and in the construction and operation of transmission lines. In 1911 Mr. Maxwell was employed by the Mississippi River Power Company in the land and tax department and remained with that company until 1926, when he joined the expansion department of the Western Public Service Company.

Claude Francis Benham (A'16, M'26) engineer in the operation and maintenance department of the Pacific Gas and Electric Company, San Francisco, Calif., died September 12, 1938. Mr. Benham was born November 15, 1889, at Bozeman, Mont., and was graduated from the University of Minnesota with a degree in electrical engineering. Following his graduation he became a substation operator for the Great Western Power Company, remaining with that company until 1930 and eventually becoming assistant to the general superintendent. He transferred his affiliation to the Pacific Gas and Electric Company as an assistant engineer in 1931.

Glendon C. Brown (M'37) electrical engineer in the research and engineering department of Cutler-Hammer, Inc., Milwaukee, Wis., died August 10, 1938. Mr. Brown was born at Fargo, N. D., January 2, 1907, and was graduated from the University of Minnesota with the degree of bachelor of science in electrical engineering in the class of 1928. He joined the research and engineering staff of Cutler-Hammer immediately following his graduation, and served that company continuously.

Membership

Recommended for Transfer

The board of examiners, at its meeting on October 20, 1938, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Member

Charlton, O. E., electrical engineer, Commonwealth and Southern Corporation, Birmingham, Ala.
Gray, T. S., assistant professor of engineering electronics, Massachusetts Institute of Technology, Cambridge.
Henderson, F. M., transmission engineer, Indiana and Michigan Electric Company, South Bend, Ind.

Laning, W. A., assistant professor of electrical engineering, University of Maryland, College Park.
 Larner, R. A., protection engineer, Texas Electric Service Company, Eastland.
 Meyers, G. J., assistant Thomson Laboratory, General Electric Company, West Lynn, Mass.
 Senn, A. H., general foreman, New York and Queens Electric Light and Power Company, Flushing, N. Y.

7 to Grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before November 30, 1938, or January 31, 1939, if the applicant resides outside of the United States or Canada.

United States and Canada

Ayvazian, A. (Member), 507 Tulsa Building, Tulsa, Okla.
 Baer, J. M., Department of Water and Power, Los Angeles, Calif.
 Benford, C. C., Benford Electric Motor Service, Santa Ana, Calif.
 Blaisdell, K. L., Connecticut Light and Power Company, Meriden.
 Bollinger, R. M., Bureau of Power and Light, Los Angeles, Calif.
 Booth, A. E., 121 South Catalina Street, Los Angeles, Calif.
 Breyer, J., Jr., 2134 Acklen Avenue, Nashville, Tenn.
 Brockhoff, F. W., Union Electric Company of Missouri, St. Louis, Mo.
 Burnside, L. L., Bureau of Power and Light, Los Angeles, Calif.
 Byers, H. O., Kansas Gas and Electric Company, Wichita, Kans.
 Carpenter, R. M., Southwestern Bell Telephone Company, Dallas, Texas.
 Clelland, J. L., Hickok Electrical Instrument Company, Cleveland, Ohio.
 Cleveland, L. F., Northeastern University, Boston, Mass.
 Collins, A. B., Langston Project, United States Housing Authority, Washington, D. C.
 Connors, R. G., Lynn Gas and Electric Company, Lynn, Mass.
 Elliott, R. D., Dallas Power and Light Company, Dallas, Texas.
 Gammell, J., Allis-Chalmers Manufacturing Company, Philadelphia, Pa.
 Garvin, W. M., Portland General Electric Company, Newberg, Oregon.
 Geiger, H. J., Jr., Locke Insulator Corporation, New Orleans, La.
 Gill, W. P., Tennessee Valley Authority, Knoxville, Tenn.
 Gindra, H. J., Union Electric Company of Missouri, St. Louis, Mo.
 Girtman, W. F., Florida Telephone Corporation, Leesburg.
 Greve, L. F. (Member), Commonwealth Edison Company, Chicago, Ill.
 Hallman, A. B., Eastern Air Lines, Inc., Newark, N. J.
 Hays, G. T., Dallas Power and Light Company, Dallas, Texas.
 Henkle, C. V. (Member), John A. Roebblings Sons Company of California, Los Angeles.
 Hood, J. E., Department of Water and Power, Los Angeles, Calif.
 Hoover, J. I., Hickok Electrical Instrument Company, Cleveland, Ohio.
 Hoye, P. B., Electrical Engineers Equipment Company, Melrose Park, Ill.
 Humak, W. P., Morganite Brush Company, Long Island City, N. Y.
 Hughes, O. L., Mississippi Power and Light Company, Jackson.
 Johnson, E. G., 1440 Broadway, Oakland, Calif.
 Jory, J. G., The Chesapeake and Potomac Telephone Company, Washington, D. C.
 Kauffman, R., Los Angeles Bureau of Power and Light, Los Angeles, Calif.
 King, H. W., The Chesapeake and Potomac Telephone Company, Washington, D. C.
 Koch, T. J., Picker X-Ray Corporation, New York, N. Y.
 Lewinson, L. J. (Member), Electrical Testing Laboratories, New York, N. Y.
 Lewis, B. F., Bell Telephone Laboratories, New York, N. Y.
 Lynn, C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
 Lutz, S. G., Southern Methodist University, Dallas, Texas.
 MacDonald, C., General Electric Company, Erie, Pa.
 McCoy, R. E., 523 N. E. Monroe Street, Portland, Ore.
 Meyer, C. A., Public Utilities Engineering and Service Corporation, Chicago, Ill.
 Mier, W. A., Southwestern Bell Telephone Company, Oklahoma City, Okla.
 Miller, C. F. (Member), Sun Oil Company, Philadelphia, Pa.

Mitchell, E. N., West Texas Utilities Company, Abilene, Texas.
 Morgan, J. F., Mercury Mills Limited, Hamilton, Ont., Canada.
 Nommensen, N. C. C., Hickok Electrical Instrument Company, Cleveland, Ohio.
 Notley, J. A., Eastbay Transit Company, Oakland, Calif.
 Odrzwolski, S. W., Bethlehem Steel Company, Lackawanna, N. Y.
 Paulsen, K., Langley Manufacturing Company, Granville Island, Vancouver, B. C., Canada.
 Peddicord, H. R., The Chesapeake and Potomac Company, Washington, D. C.
 Perry, R. H., Commonwealth Edison Company, Chicago, Ill.
 Petet, W. D. (Member), Copper Wire Engineering Association, Washington, D. C.
 Reichard, W. C. (Member), American Telephone and Telegraph Company, Netcong, N. J.
 Rogers, E. W., Dallas Power and Light Company, Dallas, Texas.
 Schmidt, E. A. (Member) I-T-E Circuit Breaker Company, St. Louis, Mo.
 Sharp, J. V., Sharp Electric Company, Salt Lake City, Utah.
 Stephens, E. H., Westinghouse Electric and Manufacturing Company, Wichita, Kans.
 Stiles, J. L., Clarkson College, Potsdam, N. Y.
 Summers, E. R., General Electric Company, Schenectady, N. Y.
 Thomas, C. U., Duquesne Light Company, Pittsburgh, Pa.
 Thornton, H. N., New England Telephone and Telegraph Company, Boston, Mass.
 Wadsworth, T. P., Jr., Department of Water and Power, Los Angeles, Calif.
 Whitaker, D. W. (Member), West Texas Utilities Company, Abilene, Texas.
 Whitmer, E. W., American Gas and Electric Service Corporation, New York, N. Y.
 Wildman, J. R., Hickok Electrical Instrument Company, Cleveland, Ohio.
 Yenawine, P. L., Department of Water and Power, City of Los Angeles, Calif.
 Young, R. A. (Member), Condon and Young, Inc., Los Angeles, Calif.

Total, United States and Canada—69

Elsewhere

de Azevedo, F. F., São Paulo Tramway, Light and Power Company, Ltd., São Paulo, Brazil.
 Edwards, G. R. T. (Member), Rangoon Electric Tramway and Supply Company, Ltd., Rangoon, Burma.
 Foong, C., Sultan Abdul Hamid College, Alor Star, Kedah, Federated Malay States.
 Muir Hunter, C. J. (Member), Callender's Cable and Construction Company, Ltd., Fort Bombay, India.
 Vowels, R. E., Hydro-Electric Commission, Tasmania, Australia.
 Sims, E. B., Tropical Oil Company, El Centro, Colombia.

Total elsewhere—6

Engineering Literature

New Books in the Societies Library

Among the new books received at the Engineering Society Library, New York, recently are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface of the book in question.

Great Britain. Mines Dept. COAL MINES ACT, 1911. GENERAL REGULATIONS as to the INSTALLATION and USE of ELECTRICITY with Explanatory Notes. London, His Majesty's Stationery Office, 1938, 69 pages, diagrams, 10 by 6 inches, paper, 1s. (obtainable from British Library of Information, 270 Madison Ave., New York, \$0.35). Contains instructions as to the kind, care and treatment, installation, and application of materials and equipment for electrical purposes, as set forth under the "Coal Mines Act."

RADIO, a Study of First Principles for Schools, Evening Classes and Home Study. By E. E. Burns. Third edition. New York, D. Van Nostrand Company, 1938. 293 pages, illustrated, 8 by 6 inches, cloth, \$2.00. Based upon material used in teaching boys of high school age. Aims to present the fundamental principles of electricity as applied in radio as simply and clearly as possible, as a basis for further theoretical and practical study.

RECHNERISCHE VERFAHREN zur HARMONISCHEN ANALYSE und SYNTHESE. By A. Hussmann. Berlin, J. Springer, 1938. 28 pages, diagrams, charts, tables, 12 by 8 inches, paper, 9.60 rm. Intended to facilitate the use of Runge's method of harmonic analysis and harmonic synthesis by providing schedules giving greater exactness. Schedules with 12, 24, 36 and 72 points are provided. Explains the general principles of harmonic analysis and synthesis, the development of the methods of calculation, and the schedule method.

(THE) ROLE of SCIENTIFIC SOCIETIES in the SEVENTEENTH CENTURY. By M. Ornstein. Chicago, University of Chicago Press, 1938. 308 pages, illustrated, 9 by 6 inches, cardboard, \$3.00. Calls attention to the ways in which scientific development was aided by the scientific societies of the seventeenth century. Contains accounts of the work of many famous scientists of the period and a description of the scientific work of the universities.

(Der) SCHUTZBEREICH von BLITZABLEITERN, Neue Regeln für den Bau von Blitz-Fangvorrichtungen. By A. Schwaiger. Munich and Berlin, R. Oldenbourg, 1938. 115 pages, diagrams, charts, tables, 9 by 6 inches, paper, 5 rm. A discussion of lightning conductors and of their effective protective range under various conditions. Using the laws of high-voltage phenomena as a basis the author has devised rules for the protection of buildings and transmission lines.

(A) SELECT BIBLIOGRAPHY on the LOCATION of INDUSTRY. (Social Research Bulletin No. 2). By D. M. McDonald. Montreal, Canada, McGill University, 1937. 84 pages, 10 by 7 inches, paper, \$0.60 + 10c postage. A list of some 700 references to books, reports, and magazine articles grouped under four heads: general references; industrial location; industrial and economic surveys; statistical, bibliographical, and other sources.

La MAISON INSONORE. By V. Gavronsky, T. Kahan and M. Blumenthal. Paris, Dunod, 1938. 119 pages, illustrated, 9 by 6 inches, paper, 38 frs. A translation of "Das laermfreie Wohnhaus," issued by the antinoise technical commission of the Society of German Engineers. Affords a description of the effect of noise upon human beings, of methods of measuring noise, and of practical methods of insulating buildings and machines.

TELEVISION, a Struggle for Power. By F. C. Waldrop and J. Borkin, with an introduction by G. H. Payne. New York, William Morrow and Company, 1938. 299 pages, 9 by 6 inches, cloth, \$2.75. Television may be expected to have profound social and political effects, and its control is of great public concern. This book discusses modern communication through the cinema, radio, and television, and calls attention to the need for a definite public policy.

ELECTRO-PLATING, a Survey of Modern Practice including Nickel, Zinc, Cadmium, Chromium, and the Analysis of Solutions. By S. Field and A. D. Weil. Third edition, revised. London, Sir Isaac Pitman and Sons, Ltd.; New York, Pitman Publishing Corporation, 1938. 381 pages, illustrated, 8 by 5 inches, cloth, \$4.00. Intended to provide the electroplater with a practical account of recent advances in the art.

STRENGTH of MATERIALS. By N. C. Riggs and M. M. Frocht. New York, Ronald Press Company, 1938. 432 pages, illustrated, 9 by 6 inches, cloth, \$3.75. Intended for use in a first course in the subject and is designed for students with a knowledge of the calculus and the fundamentals of statics.

Engineering Societies Library

39 West 39th Street, New York, N. Y.

MAINTAINED as a public reference library of engineering and the allied sciences, this library is a co-operative activity of the national societies of civil, electrical, mechanical, and mining engineers.

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